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Biological Services Program

FWS/OBS-82/52
SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume II - Lake Superior

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Navigation Season Extension Program

Fish and Wildlife Service
U.S. Department of the Interior

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- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME II
Lake Superior

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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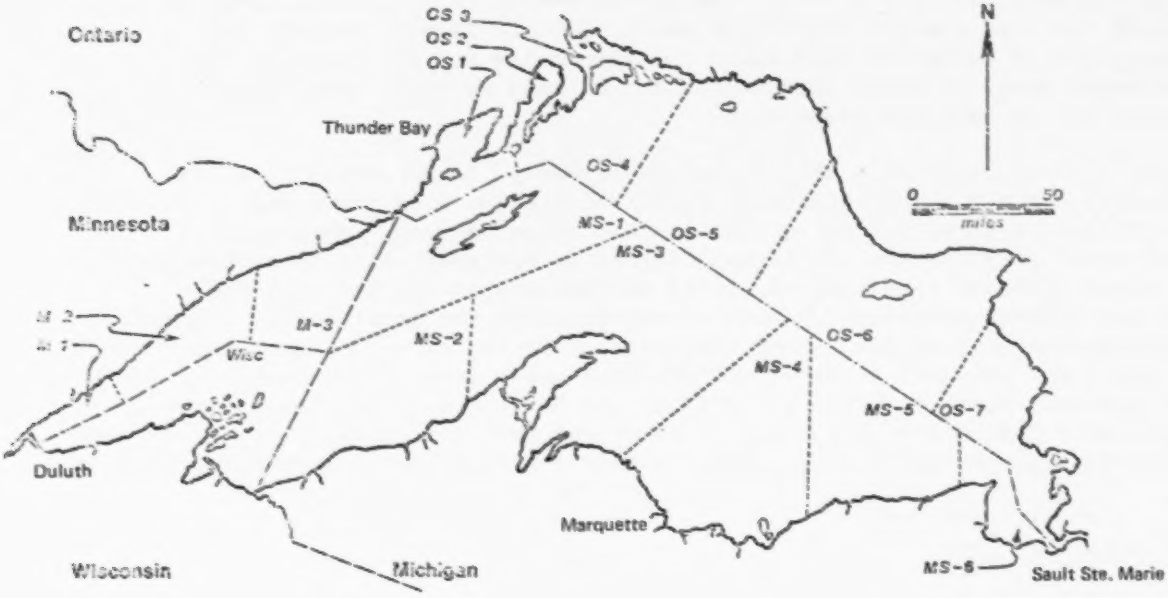
INTRODUCTION


Ontario
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Thunder Bay
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miles
Minnesota
MS-1
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Wisc
OS-6
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MS-5
OS-7
Duluth
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie

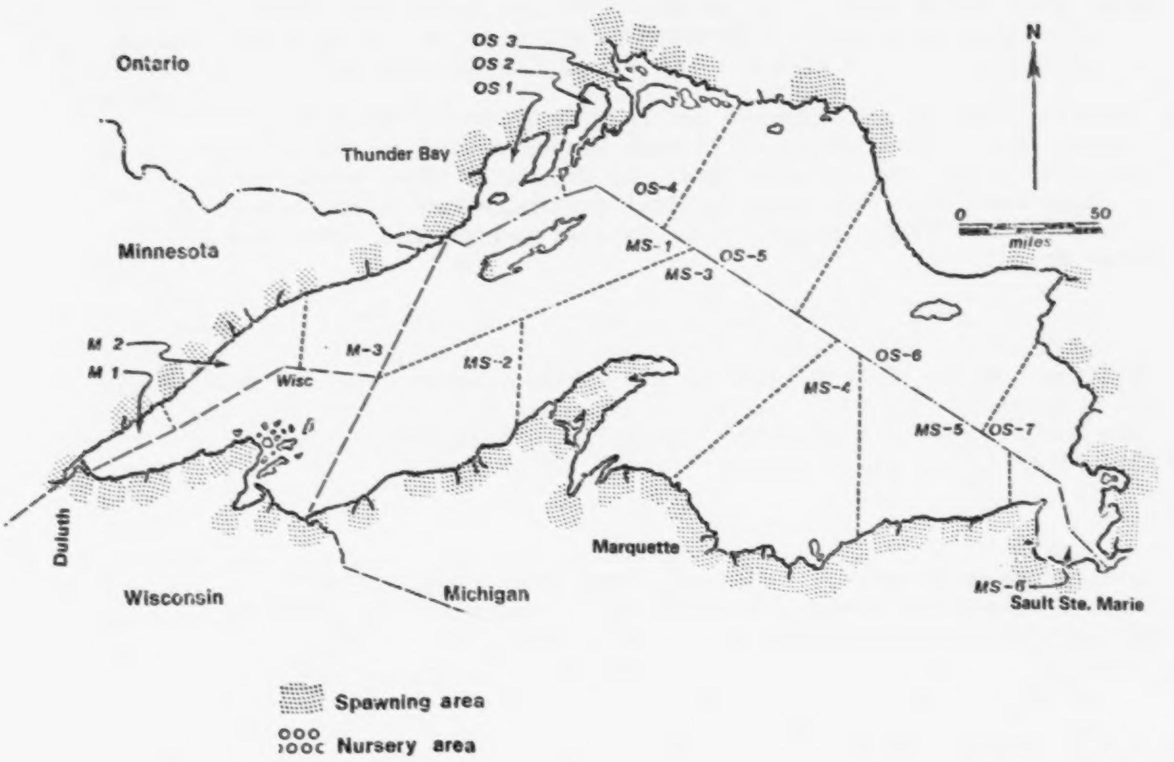
More than 60 species of fish have been recorded as residents of Lake Superior (Berg et al. 1975; Emery 1976; Lawrie 1978; Lawrie and Rahrer 1973; MWRC 1975; Selgeby, pers. comm. 1979). This volume describes the reproductive habitat used by the 49 species for which information was available. Thirty-nine species treated in this volume were native to the lake. Most of these 39 native species spawned (or spawn) in tributaries or in shallow, protected waters of the lake. Only six species, including the lake trout, lake herring, three species of ciscoes, and the fourhorn sculpin, utilized the deep offshore waters for spawning. Two of these deepwater spawners, the blackfin cisco and shortnose cisco, are now believed to be extinct. Only the lake trout spawned in the tributaries, the shallow nearshore waters, and the deeper offshore waters.

The nine exotic species treated in this volume were introduced by man, or immigrated to the lake during the period of record, from populations established elsewhere in the Great Lakes drainage. Five of these are salmonids which are believed to spawn exclusively in tributaries. The other four spawn in tributaries and also in protected nearshore waters in some areas.

Information on nursery areas used by the 49 species treated in this volume is fragmentary, but as would be expected, it suggests that tributaries and nearshore waters are important as nursery areas, at least for the earliest life history stages. Dispersal from spawning areas is rapid for some species which have small, pelagic larvae, whereas the juveniles of salmonids that spawn in tributaries may remain in or near spawning areas in those tributaries for as many as three years before entering the lake and dispersing.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Each species narrative presents the available information systematically by statistical fishing district (Smith et al. 1961) beginning with district M-1 and ending with district OS-7. Within each district the presentation proceeds systematically from one end of the district to the other, by shoreline segment and adjacent littoral and offshore water areas. For each referenced location within a district, the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

SEA LAMPREY


Ontario
OS 3
OS 2
OS 1
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Thunder Bay
OS-4
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50
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Minnesota
MS-1
OS-5
MS-3
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M 1
M-3
MS-2
OS-6
Wisc
MS-4
MS-5
OS-7
Duluth
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie
Spawning area
Nursery area

The sea lamprey presumably entered Lake Superior from Lake Huron via the St. Marys River. The first recorded capture occurred near Marquette in 1938 (Dees 1980; Smith and Tibbles 1980). An immature adult was taken at Isle Royale in 1946 (Applegate 1947, 1950), and spawning runs were established by 1950 in the eastern half of the lake and also near Duluth (Applegate and Smith 1950, 1951; Applegate et al. 1952; Smith 1971). Spawning runs into Lake Superior tributaries occur in May-July and usually peak in late May to mid-June; adult in spawning condition may be found into September (Fish. Res. Board Can. 1955; GLFC 1973b; Hanson and Manion 1978; Lawrie 1974; Manion and McLain 1971; Price 1955, 1956; SLCC 1979b; Smith and Braem 1976).

Sea lamprey ammocoetes have been found in at least 133 tributaries (Dees 1980). Ammocoetes also commonly occur in many bays, harbors, and mouth areas of spawning streams and as far as 2 mi offshore from spawning streams, especially in dropoff areas (Braem and Rugen 1976; Gollat 1976; GLFC 1973b, 1975; Smith and Braem 1976; Thomas 1961a,b, 1962, 1966; Tibbles 1975; Tibbles et al. 1976a; Wagner and Stauffer 1962).

The tributaries listed below are classified as spawning streams based on the presence of ammocoetes, spawning adults, or both.

Minnesota

Spawning runs of sea lampreys are rare or absent in Minnesota tributaries because of barrier falls near stream mouths and unsuitable bedrock substrate in the streams (Eddy and Underhill 1974; Morman et al. 1980). Runs have occurred in the following streams (Smith and Braem 1976; Smith et al. 1974; Thomas 1961a; Torblaa and Westman 1980, unless otherwise noted).

M-1

St. Louis River (46°45', 92°06') (H. Johnson, pers. comm. 1979).

Big Sucker Creek (Sucker River) (46°55', 91°51'), Knife River (46°57', 91°47'), and Stewart River (47°03', 91°38').

M-2

Gooseberry River (47°08', 91°27'), Split Rock River (47°11', 91°24'), Baptism River (47°20', 91°12'), Cross River (47°32', 90°53'), and Poplar River (47°38', 90°42').

M-3

Cascade River (47°42', 90°31') (Hassinger, pers. comm. 1979).

Brule (Arrowhead) River (47°49', 90°03') and Pigeon River (48°00', 89°34').

Wisconsin

Spawning runs enter the following streams (Bails et al. 1971; Braem and Rugen 1976; FWS 1979a; GLFC 1973b, 1975; Moore and Braem 1965; Smith 1971; Smith and Braem 1976; Smith et al. 1974; Torblaa and Westman 1980).

Nemadji River (46°42', 92°02'), Amnicon River (46°41', 91°51'), Middle River (46°42', 91°50'), Poplar River (46°42', 91°47'), Brule River (46°45', 91°37'), Fish Creek (46°45', 91°31'), Reefer Creek (46°46', 91°30'), Cranberry River (46°50', 91°16'), Siskiwit River (46°51', 91°06'), Sand River (46°56', 90°56'), Raspberry River (46°56', 90°50'), Fish Creek (46°35', 90°57'), Bad and White Rivers (46°38', 90°39'), and Montreal River (46°34', 90°25').

Michigan

The following streams have spawning runs (Bails et al. 1971; Braem and Rutgen 1976; Erkkila et al. 1956; FWS 1979a,c; GLFC 1973b, 1975; Loeb and Hall 1952; Moore and Braem 1965; Smith 1971; Smith and Braem 1976; Smith et al. 1974; Stauffer and Hansen 1958; Torblaa and Westman 1980; Wagner and Stauffer 1962).

MS-1

Washington Creek (47°55, 89°09').

MS-2

Black River (46°40', 90°03'), Union River (46°49', 89°37'), Little Iron River (46°50', 89°35'), Cranberry River (46°50', 89°25'), Potato River (46°51', 89°23'), Ontonagon River (46°52', 89°20'), Flint Steel River (46°56', 89°12'), Fire Steel River (46°56', 89°12'), Sleeping River (46°59', 89°04'), and Misery River (47°00', 88°59').

MS-3

Elm River (47°03', 88°55), Graveraet River (47°07', 88°51'), Mud Lake Outlet (47°08', 88°17'), Salmon Trout River (47°09', 88°46'), Boston-Lily Creek (47°11', 88°38'), Smith Creek (47°15', 88°34'), Gratiot River (47°21', 88°27'), Trap River (Eliza Creek) (47°28', 88°10'), Little Gratiot River (47°22', 88°02'), Traverse River (47°11', 88°14'), Trap Rock River (47°11', 88°24'), McCallum Creek (47°09', 88°24'), Pilgrim River (47°06', 88°31'), Sturgeon River (47°02', 88°29'), Six Mile Creek (46°45', 88°30'), Falls River (46°45', 88°27'), Silver River (46°49', 88°17'), Slate River (46°50', 88°16'), Ravine River (46°50', 88°15'), Huron River (46°55', 88°02'), Pine River (46°53', 87°52'), and Salmon Trout River (46°52', 87°46').

MS-4

Little Iron River (46°49', 87°39'), Big Garlic River (46°43', 87°34'), Little Garlic River (46°41', 87°31'), Harlow Creek (46°38', 87°28'), Dead River (46°34', 87°23'), Carp River (46°31', 87°23'), Chocolay River (46°30', 87°21'), Sand River (46°30', 87°06'), Laughing Whitefish River (46°31', 87°02'), Deer Lake Creek (46°28', 86°57'), Rock River (46°28', 86°55'), Au Train River (46°26', 86°51'), Five Mile Creek (46°28', 86°44'), Furnace Creek (46°26', 86°42'), Anna River (46°25', 86°38'), Munising Falls Creek (46°27', 86°36'), Miners Creek (46°30', 86°33'), and Mosquito River (46°32', 86°30').

MS-5

Beaver Lake Creek (46°35', 86°21'), Seven Mile Creek (46°37', 86°16'), Sullivan Creek (46°39', 86°11'), Hurricane River (46°40', 86°10'), Sable Creek (46°40', 86°01'), Carpenter Creek (46°40', 85°59'), Sucker River (46°40', 85°56'), Blind Sucker River (46°41', 85°40'), Big

Two Hearted River (46°42', 85°25'), Little Two Hearted River (46°43', 85°22'), and Carp River (Three Mile Creek) (46°44', 85°19').

MS-6

Pendills Creek (46°27', 84°49'), Grants Creek (46°28', 84°52'), Halfaday Creek (46°28', 84°54'), Naomikong Creek (46°29', 84°58'), Ankodosh Creek (46°29', 85°00'), Galloway Creek (46°32', 85°03'), Tahquamenon River (46°33', 85°02'), and Betsy River (46°41', 85°01').

Ontario

Sea lamprey do not spawn as extensively in Canadian tributaries to Lake Superior as in U.S. tributaries. Most sea lamprey spawning in Ontario waters occurs in tributaries to Whitefish Bay (46°40', 84°50') (Price 1955; SLCC 1979b). Spawning runs enter the following streams (Gollat 1976; GLFC 1973b, 1975; Lawrie 1955b; Price 1955, 1956; SLCC 1979a,b; Smith 1971; Smith et al. 1974; Speirs 1955; Thomas 1961a; Tibbles 1975; Tibbles et al. 1976a,b; Torblaa and Westman 1980).

OS-1

Pine River (48°03', 89°30'), Cloud River (48°05', 89°26'), Kaministiquia River (48°23', 89°13'), Neebing River (48°24', 89°13'), McIntyre River (48°25', 89°13'), Current River (48°27', 89°11'), MacKenzie River (48°32', 88°57'), and Blende River (48°34', 88°46').

OS-2

Pearl River (48°37', 88°37'), Wolf River (48°49', 88°29'), and Black Sturgeon River (48°50', 88°24').

OS-3

Stillwater Creek (48°59', 88°16'), Nipigon River (48°57', 88°15'), Cash Creek (49°06', 88°15'), Jackfish River (49°00', 88°05'), Jackpine River (48°58', 88°00'), Cypress River (48°56', 87°52'), Little Gravel River (48°55', 87°46'), Gravel River (48°55', 87°46'), Pays Plat River (48°53', 87°34'), and Hewitson River (48°50', 87°27').

OS-4

Otter Cove Creek (48°34', 88°19').

OS-5

Steel River (48°46', 86°54'), Prairie River (48°47', 86°47'), Little Pic River (48°47', 86°38'), Pic River (48°36', 86°18'), and White River (48°33', 86°16').

OS-6

University (Dog) River (47°58', 85°12') and Michipicoten River (47°56', 84°51').

OS-7

Sand River (47°26', 84°44'), Agawa River (47°21', 84°38'), Pancake River (46°58', 84°40'), Sable River (46°57', 84°35'), Batchawana River (46°56', 84°32'), Chippewa River (46°56', 84°27'), Sawmill Creek (46°53', 84°22'), Harmony River (46°51', 84°23'), Stokely Creek (46°49', 84°25'), Havilland Creek (46°49', 84°25'), Goulais River (46°43', 84°27'), and Cranberry Creek (46°42', 84°25').

LAKE STURGEON

Lake sturgeon spawned later in the year in Lake Superior than in the other Great Lakes; in Lake Superior the females were still full of spawn in late July (Milner 1874a).

Minnesota

M-1

St. Louis River (46°45', 92°06'). Spawning runs occurred in this river in the spring (Kaups 1978; Schram, pers. comm. 1979), and a remnant population is still present (Hassinger, pers. comm. 1979).

M-3

Pigeon River (48°00', 89°34'). A remnant population is present at Grand Portage (47°58', 89°41') and may be associated with the river (Hassinger, pers. comm. 1979).

Wisconsin

Bayfield (46°49', 90°49'). Ripe fish were observed here in late July (Milner 1874a).

Bad River (46°38', 90°39'). A spawning run moves upstream to Amherst Falls in the late spring-early summer (Bolton, pers. comm. 1979; King and Swanson, pers. comm. 1979). Sturgeon were collected here at the U.S. Fish and Wildlife Service (FWS) sea lamprey weir (Moore and Braem 1965).

Michigan

MS-3

Sturgeon River (47°02', 88°29'). Sturgeon were observed at the FWS sea lamprey weir in this river (Moore and Braem 1954).

Pine River (46°53', 87°52'). Sturgeon ran into the mouth of the Pine River (Hubbs 1929).

MS-6

Tahquamenon River (46°33', 85°02'). This river formerly supported a run (Hankinson 1916).

Ontario

Spawn was taken for caviar along the Canadian shore (Smith and Snell 1891).

OS-5

Big Pic River (48°36', 86°18'). This was a spawning ground (Ont. Game Fish 1912).

OS-7

Goulais River (46°43', 84°27'). Adults were captured at the FWS sea lamprey weir in the river in the mid-1950s (Price 1955). Sturgeon spawned in the river, and young about 3 in. long were present (Lamsa, pers. comm. 1979).

ALEWIFE

The alewife presumably entered Lake Superior through the St. Marys River (Miller 1957). Alewives were first observed in Lake Superior in about 1954, but the species has not reproduced very successfully and is not abundant (Gollat 1976).

Minnesota

M-1

Duluth Harbor (46°45', 92°05'). The harbor is a spawning and nursery area; alewives run into the harbor in late June-early July (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979).

M-2

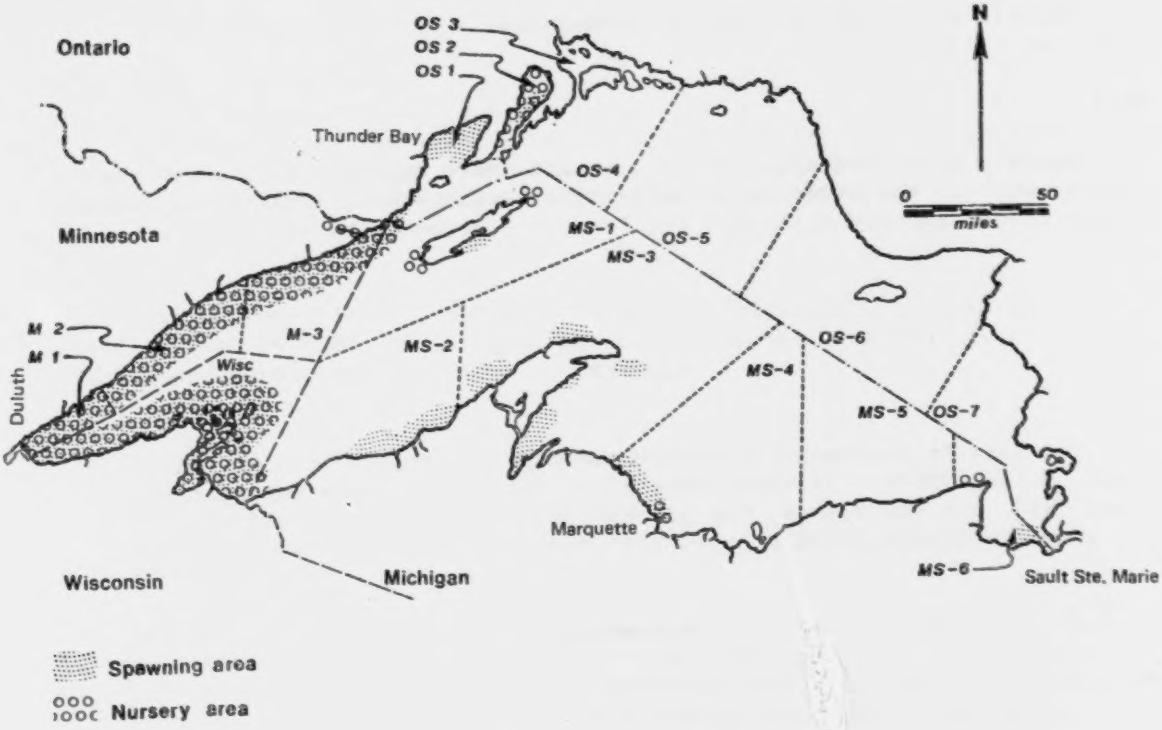
Split Rock River (47°11', 91°24'). Young-of-the-year (YOY) have been collected intermittently in the river (Hassinger, pers. comm. 1979).

Wisconsin

Chequamegon Bay (46°40', 90°50'). A population of alewives resides in the bay and may spawn there; YOY were present in weedy areas at the head of the bay (Pratte and Swanson, pers. comm. 1979).

Superior Harbor (46°42', 92°01'). This is a spawning area, and alewife fry have been collected here (CDM/Limnetics 1976b).

LAKE HERRING


Ontario
OS 3
OS 2
OS 1
Thunder Bay
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miles
OS-4
Minnesota
MS-1
OS-5
MS-3
M 2
M 1
M-3
MS-2
Wisc
Duluth
OS-6
MS-4
MS-5
OS-7
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie
Spawning area
Nursery area

In Lake Superior, lake herring migrate inshore during October-December (USBCF 1969b). Peak spawning occurs during the last 2 weeks of November and the first week of December, when the water temperature drops to 37-40°F (Anderson 1969; Cook 1929; Dryer and Beil 1964; Eddy and Underhill 1974; Koelz 1926; Lawrie 1978; Peck 1975a; USDI 1970). Spawning occurs pelagically at depths of a few feet to 150 ft over a variety of substrates (Dryer and Beil 1964; Eddy and Underhill 1974; Peck 1975a). The most productive commercial fishing areas and most favorable spawning grounds were in the western part of the lake from Thunder Bay (48°25', 89°00'), Ontario, south to the Apostle Islands (47°00', 90°40'), Wisconsin (Koelz 1926). A very productive historic spawning and nursery area extended from the Knife River (46°57', 91°47'), to the Apostle Islands, (Hassinger, pers. comm. 1979; Sve, pers. comm. 1979). Herring in the west end of the lake are believed to be bottom spawners, whereas those in the eastern part of the lake spawn over deep water (GLFC 1968c).

Minnesota

Today, very little spawning occurs along the Minnesota shore, but historically, lake herring moved inshore in large numbers to spawn along the entire shore from the Pigeon River (48°00', 89°34') south to Duluth (46°48', 92°05'). Until the early 1950s, "blueback" herring came in during the fall to spawn pelagically from the shoreline out to depths of 300 ft, from Grand Portage (47°58', 89°41') to the Knife River (46°57', 91°47'). Ripe fish were taken with float nets at various depths from the surface down. "Bottom" or "redback" herring came in during the fall to spawn on the bottom from the shore out to depths of 300 ft, from the Knife River to Port Wing (46°47', 91°23'), Wisconsin. Ripe fish were taken with bottom nets (Hassinger, pers. comm. 1979). Shoreward migration began as early as October and spawning usually occurred in November and December. There are also records of nearshore catches in January.

Various shoreline spawning migrations have been identified. One migration involved a westward movement along the Minnesota North Shore towards Duluth prior to the spawning season, followed by a return movement along the same route after the spawning season. A similar migration originating in the Apostle Islands (47°00', 90°40') occurred along the Wisconsin shore. Some North Shore fishermen also reported that the best catches were made in October while the herring were moving east on a southwest current, presumably to spawning grounds in Pigeon (48°01', 89°31'), Cloud (48°05', 89°26'), Thunder (48°25', 89°00'), or Black (48°40', 88°30') bays; catches were again good in December, when the herring were moving back to the west (Fenstad, pers. comm. 1979; FWS 1979d; W. Johnson, pers. comm. 1979; Kaups 1978; Koss and Koss, pers. comm. 1979; Minn. DNR 1937-59, 1946; Spry, pers. comm. 1979; Sve, pers. comm. 1979; Zerbach, pers. comm. 1979). Herring congregated along the North Shore in large numbers until mid-November, and then migrated into Wisconsin waters at the western end of the South Shore to spawn (Dunn 1918).

Post-spawning adults and young-of-the-year (YOY) were pelagic. Young herring frequented the waters along the northern Minnesota shoreline. Fishermen often observed young herring, at the surface in bays and shoreline areas during the summer, and collected them for use as bait (Fenstad, pers. comm. 1979; Hassinger, pers. comm. 1979; Hendrickson, pers. comm. 1979; Koss and Koss, pers. comm. 1979; Spry, pers. comm. 1979; Zerbach, pers. comm. 1979).

M-1

Two Harbors (47°01', 91°40'). Fishing occurred inshore during the spawning season (Croft, pers. comm. 1979).

French River (46°54', 91°53'). Pelagic spawning occurred in this area during November in water 240-300 ft deep (W. Johnson, pers. comm. 1979). Eggs have been collected from fish caught at the mouth of the river (Eddy and Underhill 1974).

Duluth Harbor (46°45', 92°05'). The harbor area supported spawning until the 1940s, when the run declined because of pollution (Fenstad, pers. comm. 1979). During the late 1960s, ripe adults were collected in November and December, just outside the harbor at 46°46', 92°02', and eggs (Coregonus spp.) were found in late November. Hatching occurred in April and early May, and early larvae (Coregonus spp.) were collected near the surface beginning in late April. Densities of larvae peaked in late May and early June and declined dramatically in June and early July. The number of spawners in the area decreased recently, possibly due to large concentrations of smelt which may have crowded the herring off the spawning ground (Anderson 1969; Anderson and Smith 1971). [Authors' note: Eggs and larvae identified as "Coregonus spp." by Anderson 1969 and Anderson and Smith 1971 were presumed by these authors to be eggs and larvae of lake herring.]

M-2

Little Two Harbors (47°12', 91°22'). Ripe and running adults were caught in November (Sve, pers. comm. 1979).

M-3

Pigeon Bay (48°01', 89°31'). Pelagic spawners moved inshore on about October 15 to sandy areas 25-30 ft deep near the Pigeon River (48°00', 89°34'). Young-of-the-year were found along the bay side of Pigeon Point (48°00', 89°30') and at the narrows in the bay (Fenstad, pers. comm. 1979; Hendrickson, pers. comm. 1979; Koss and Koss, pers. comm. 1979).

Wauswaugoning Bay (47°58', 89°37')--Grand Portage Bay (47°57', 89°40'). Very large numbers of herring entered the bays on about October 15, and young were found at the head of Wauswaugoning Bay, around the islands off the mouth of the Grand Portage River (47°58', 89°41') and in the river proper prior to 1955 (Fenstad, pers. comm. 1979; Hendrickson, pers. comm. 1979; Spry, pers. comm. 1979).

Big Bay (47°52', 89°55'). Young herring were caught here for use as bait (Koss and Koss, pers. comm. 1979).

Red Cliff Bay (47°47', 90°10'). The area off Kadunce Creek (47°48', 90°09') was one of the best fishing areas during the peak of spawning in November-December (Zerbach, pers. comm. 1979).

Grand Marais (47°45', 90°20'). Fishing was carried out from early October to early December and peaked in November (Koelz 1929). Young were found during the summer in bays (Zerbach, pers. comm. 1979). In 1922, YOY were found in Grand Marais Harbor and at the mouth of the Devil Track River (47°46', 90°16') in mid-July (Koelz 1929).

Wisconsin

Lake herring migrated through the Minnesota waters to spawn in large numbers in mid-November over the shallow mud bottom along the western Wisconsin shore; spawners were present on the spawning grounds for about 3 weeks and then disappeared (Dunn 1918). More recently, commercial fishermen reported that herring spawned on mud and silt along shore from Superior (46°44', 92°05') to the Apostle Islands (47°00', 90°40'). The run began earlier in the western end of the lake, peaked just before Thanksgiving, and ended on about December 7. Adults were also caught during the spawning season from the Apostle Islands to Marble Point (46°35', 90°30'), usually in water less than 240 ft deep (Coberly and Horrall 1980b).

In Wisconsin waters, there are two varieties of lake herring, both of which spawned during November-December: the "deep", "deepwater", "mud", or bottom herring that spawns in deep water, and the "reef" herring that spawns slightly earlier on the shallow, rocky reefs used by whitefish (Coberly and Horrall 1980b; King and Belonger 1970; King and Swanson 1975, pers. comm. 1979; Peck 1975a; Peck et al. 1974). Spawning also occurs at the following sites, most of which are in the Apostle Island region.

Superior Harbor (46°42', 92°01'). Lake herring spawn at the harbor entry (Pratt and Swanson, pers. comm. 1979).

Port Wing (46°47', 91°23'). The spawning run began here in mid-November (Coberly and Horrall 1980b). The abundance of spawners recently has been very low (King and Belonger 1970).

Siskiwit Bay (46°52', 91°07'). In the 1950s, this was a very important fishing area during the spawning run (Scott et al. 1978), which began in mid-November (Coberly and Horrall 1980b). The abundance of spawners at Cornucopia (46°51', 91°06') recently has been very low (King and Belonger 1970).

Apostle Islands (47°00', 90°40')--Bayfield (46°49', 90°49'). Fishing was conducted during the spawning season in this historical spawning area. Herring congregated in large schools prior to spawning in water 90-150 ft deep (Dryer 1966; Dryer and Beil 1964; King, pers. comm. 1979; Lawrie and Rahrer 1973; Selgeby et al. 1978). In 1960, ripe adults were observed here as late as December 20 (Dryer and Beil 1964). Eggs (Coregonus spp.) were collected in late November and early December (Anderson 1969; Anderson and Smith 1971). Larvae were collected mainly at the surface in this area, from late April to mid-June (Anderson 1969; Selgeby 1978; Selgeby et al. 1978; Smith 1954).

> Sand Island (46°59', 90°57'). Reef herring spawned on the north and east shores of the island (Coberly and Horrall 1980b). Lake herring spawn north of the island over a clay and ooze substrate in water 600-930 ft deep (King and Swanson, pers. comm. 1979). This was one of the most productive fishing areas for mud herring (Coberly and Horrall 1980b).

York Island Shoals (47°01', 90°51')--Bear Island Shoal (47°02', 90°49'). Reef herring spawn here (Coberly and Horrall 1980b; King and Swanson, pers. comm. 1979). Larvae (Coregonus spp.), many with yolk sacs, were collected beginning in April at an unnamed site (47°05', 90°53') 6 mi N of York Island; eggs (Coregonus spp.) were also collected there in April and May (Anderson 1969, Anderson and Smith 1971).

Bear Island (47°01, 90°45'). Ripe adults were collected off the southeast shore in November and December, and eggs (Coregonus spp.) were found in late November and early December. Larvae (Coregonus spp.), many with yolk sacs, were also collected beginning in late April (Anderson 1969; Anderson and Smith 1971). Reef herring were the main catch here (Coberly and Horrall 1980b).

Raspberry Island (46°58', 90°48'). This was a spawning area for reef herring. Mud herring spawned in the Raspberry-Oak Island Channel (Coberly and Horrall 1980b).

Rocky Island (47°02', 90°41')--South Twin Island (47°02', 90°39'). This was a spawning area for reef herring (Coberly and Horrall 1980b).

Outer Island Shoal (47°05', 90°25'). Reef herring spawn on Outer Island Shoal off the north side of the island (King and Swanson, pers. comm. 1979).

Stockton Island (46°56', 90°35'). Mud herring spawned along the north shore (46°58', 90°36') and reef herring spawned at Presque Isle Point (46°55', 90°33') (Coberly and Horrall 1980b).

Gull Island Shoal (46°57', 90°24'). This was a spawning area for mud herring (Coberly and Horrall 1980b).

Michigan Island (46°53', 90°29'). Reef herring spawned along the southeast shore (Coberly and Horrall 1980b). Reef herring spawn on the shoals off the northeast end of the island at 46°51', 90°33' (King and Swanson, pers. comm. 1979).

Madeline Island (46°50', 90°40'). Spawning occurs in late November-early December from Big Bay (46°49', 90°38') to the southwest end of the island in a 100-150 ft deep trench with a bottom of clay and sand (Coberly and Horrall 1980b; King and Swanson, pers. comm. 1979). Big Bay was one of the most important fishing areas during the spawning season (Coberly and Horrall 1980b; Scott et al. 1978). In the late 1960s, some viable eggs (Coregonus spp.) were present in Big Bay in April and early May, and larvae (Coregonus spp.), many with yolk sacs, appeared in late April. Ripe adults were present west of Pt. De Froid at 46°46', 90°50' in November and December, and viable eggs (Coregonus spp.) were found in early December (Anderson 1969; Anderson and Smith 1971). The North Channel

(46°51', 90°42') and Bayfield-Madeline Channel (46°48', 90°49') were also spawning areas for deep herring (Coberly and Horrall 1980b).

Hermit Island (46°53', 90°41'). Mud herring spawned in the west channel (46°54', 90°43') northwest of the island (Coberly and Horrall 1980b).

Long Island (46°43', 90°46'). Reef herring spawned all along the east shore of the island and along the Wisconsin shore to Marble Point (46°35', 90°30') (Coberly and Horrall 1980b). Spawning occurs between Houghton Point (46°42', 90°51') and the west tip of Long Island (46°43', 90°49) in 60-70 ft of water (King and Swanson, pers. comm. 1979).

Oronto Bay (46°35', 90°26'). Spawning occurred all along the shore of the bay (Coberly and Horrall 1980b). Spawning occurs west of Little Girls Point (46°37', 90°20') at a depth of more than 100 ft (King and Swanson, pers. comm. 1979). The nearshore area along the Wisconsin-Michigan boundary (46°34', 90°25') has been the main fishing ground for the Wisconsin fishery during the spawning run in November and December (King and Belonger 1970).

Michigan

Both the deepwater and "shallow water" herring also occur in Michigan waters, but the deepwater type is more abundant (Peck 1975a; Wilson, pers. comm. 1979). Commercial catches were taken in mid-November to the first or second week of December and were usually highest in late November (Anderson 1910-1926).

MS-1

Isle Royale (48°00', 88°50'). Since the early 1900s, lake herring spawned in Siskiwit Bay (47°57', 88°50') over sand bottom in 45-80 ft of water from mid-November to the end of December (Organ et al. 1978). A commercial fisherman identified one type of herring that spawned near the surface over deep water and another type that spawned in shallow water over sand. In 1905, young herring, 1 1/2 in. long, were collected at the head of Tobin Harbor (48°09', 88°30') in late July; young herring were also collected (date not specified) in a cove opposite Thompson Island (47°54', 89°14') (Hubbs and Lagler 1947).

MS-2

Union Bay (46°50', 89°37')--Misery Bay (47°00', 89°01'). The deepwater herring spawns in this area in November over mud and rock substrate in water 210-240 ft deep. Spawning shallow water herring were caught over shallow, rocky areas off Green City (49°50', 89°26') in November; spawning also probably occurs east and west of here along the shoreline (Wilson, pers. comm. 1979). At Green City, spawning occurs in rock gullies extending from Stony Creek (46°50', 89°30') east to the Potato River (46°51', 89°23'); in 1937-1954, spawning occurred in mid-November through December (Organ et al. 1978). Large numbers of spawners moved into the shallows at Ontonagon (46°53', 89°19') in mid-November to early December (Koelz 1929).

MS-3

Keweenaw Peninsula (47°10', 88°30'). Spawning generally occurs in November at the following areas (Organ et al. 1978):

> Redridge (47°09', 88°46'). A rocky area (47°09', 88°46'--47°13', 88°41'), used since 1968 extends 5-6 mi along the shore north of Redridge. McGunn's Creek (47°15', 88°33'). A rocky area, used since 1968, extends for about 5 mi from 47°15', 88°34'--47°18', 88°30'. Eagle Harbor (47°28', 88°09')--Agate Harbor (47°28', 88°03'). A rocky area (47°28', 88°11'--47°29', 88°01') used since 1963 extends along shore in this area. Manitou Island (47°25', 87°37'). The rocky shoals around the island have been used at least since 1963. Point Isabelle (47°21', 87°56'). During 1936-73, a nearshore rocky area (47°17', 88°01') 5-6 mi S of the point was used. Traverse Point (47°08', 88°14'). The rock areas around the point were used at least until 1969 and a mud area (47°07', 88°14'--47°05', 88°17') between the point and Traverse Island (47°04', 88°16') was used until the 1960s.

Keweenaw Bay (46°58', 88°20'). In 1951, the first spent adult was collected on November 12 (Dryer and Beil 1964). Commercial fishermen report spawning occurs in the bay from November (sometimes mid-October) to mid-December in water 4-180 ft deep. Both shallow and deepwater forms spawn in the bay and several locations have been identified:

> Traverse Island (47°04', 88°16'). Since the mid-1960s, herring spawned in November on the shoals around the island and also in the deep, mud gullies (47°07', 88°14'--47°05', 88°16'; 47°03', 88°13'--46°57', 88°20') extending south on both sides of the island into the bay (Organ et al. 1978; Wilson, pers. comm. 1979).
>
> Portage River (46°58', 88°26'). Since 1965, spawning occurred over mud off the mouth of the river. Community of Keweenaw Bay (46°52', 88°29'). During the 1940s, spawning occurred at 46°52', 88°27' over sand. Assinins (46°49', 88°28'). During the 1940s, spawning occurred at 46°49', 88°27' over sand. Pequaming (46°51', 88°24'). Until 1974, spawning occurred at 46°51', 88°26' over sand (Organ et al. 1978).

MS-4

Big Bay (46°50', 87°43'), Sauk Head (46°43', 87°34')--Thoney Point (46°41', 87°31'), Granite Point (46°38', 87°27')--Little Presque Isle (46°38', 87°28'), and Partridge Island (46°36', 87°25'). Herring were taken here in November and December (Anderson 1910-26).

Marquette (46°33', 87°23'). During mid-November-early December large numbers of herring moved inshore to sand areas at depths as shallow as 48-60 ft east and northwest of Marquette (Koelz 1929). Herring were caught in November and December at Presque Isle (46°35', 87°23'). Larvae believed to be lake herring were found February-April 1975 in Presque Isle Harbor (46°34', 87°23'), but no spawning was observed (Wapora 1976b).

MS-5

Grand Marais (46°40', 85°59'). During late September herring moved onshore to sand areas at depths as shallow as 18-24 ft, then migrated out of the area in early December (Koelz 1929).

MS-6

Whitefish Point (46°46', 84°57'). In 1913, large schools of small herring were seined over sandy bottom in less than 3 ft of water near the Vermilion Life Saving Station in August (Hankinson 1914).

Iroquois Shoal (46°30', 84°40'). Commercial fishermen reported that herring spawned on the shoal over rock and gravel in October and November until 1963, when runs suddenly ceased (Organ et al. 1978). The shoal area, between Iroquois Island (46°30', 84°41'), and the mainland was an excellent spawning ground until dredging occurred there in the 1960s; thereafter the herring apparently moved their spawning grounds to an unknown location on the Canadian side of Whitefish Bay (46°40', 84°40'). However, spawning adults were collected in the Iroquois Shoal area in November, 1978 (FWS 1977, 1979d; Gleason and Behmer, pers. comm. 1979).

Ontario

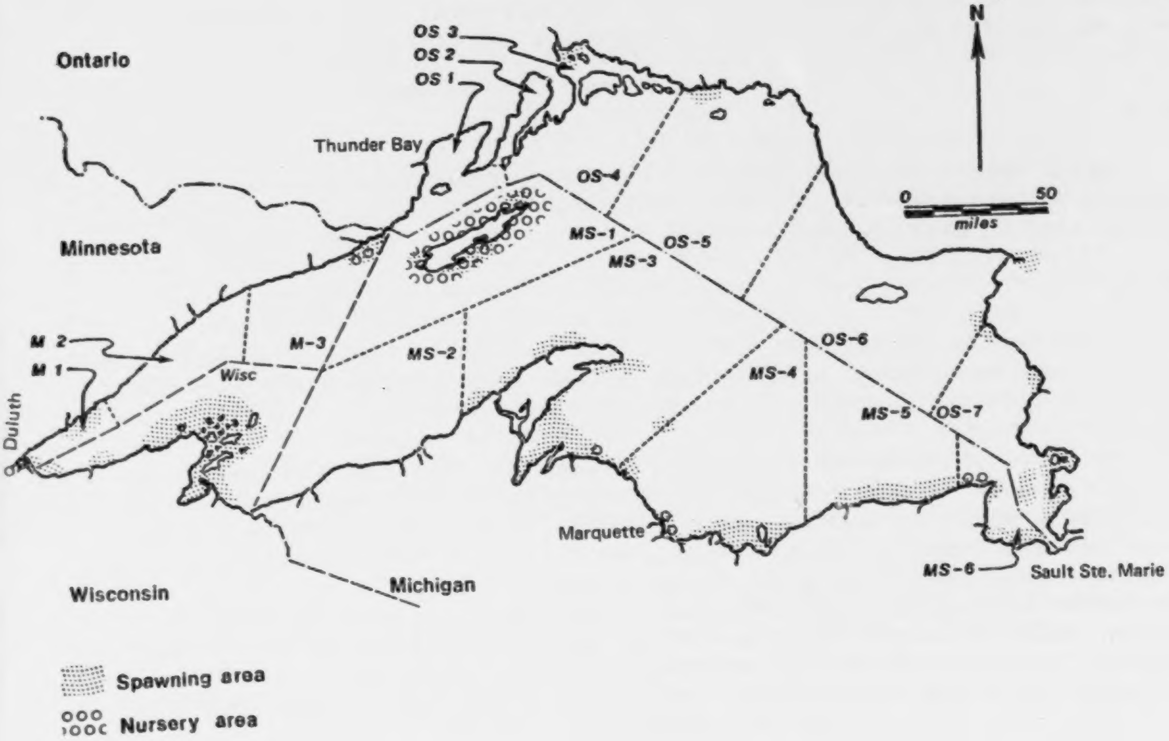
OS-1

Thunder Bay (48°25', 89°00'). Lake herring moved into the bay, spawned in mid-November and left in early December; spawning occurred during this time, pelagically over mud and clay in 36-150 ft of water (Koelz 1929), and large commercial catches were made (Ont. Game Fish 1909, 1912, 1913a,b, 1915, 1916). Large amounts of spawn were collected in the bay from ripe fish (Rodd 1917). In 1979, spawning continued into late December (Hendrickson, pers. comm. 1979).

OS-2

Black Bay (48°40', 88°30'). This is the site of the last large fishery for herring; the fish are caught by trawling during the spawning season (Selgeby et al. 1978). A spawning site extends 10-12 mi from George Point (48°29', 88°36') in a northerly direction (Gollat 1976). The deeper southern part of the bay and the deeper trenches of the northern portion of the bay have the greater abundance of spawning herring (OMNR 1975b). Larvae were present throughout the bay but were concentrated in the lower two thirds of the bay (Selgeby 1978; Selgeby et al. 1978). The concentration of larvae in Black Bay was 78 times higher than in the Apostle Islands (47°00', 90°40') (Pycha and Selgeby 1975).

LAKE WHITEFISH


OS 3
OS 2
OS 1
Ontario
Thunder Bay
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Minnesota
MS-1
OS-5
MS-3
M 2
M-3
MS-2
OS-6
M 1
Wisc
MS-4
Duluth
MS-5
OS-7
Marquette
MS-6
Sault Ste. Marie
Wisconsin
Michigan
Spawning area
Nursery area

Lake whitefish in Lake Superior move inshore in mid-September to late October, sometimes congregating at river mouths, and spawn in November at depths of 6-75 ft over sand, gravel, or small stones (Eddy and Underhill 1974; Hankinson 1916; Koelz 1929; MacKay 1957f, 1969; Rathbun and Wakeham 1897). The substrate used for spawning often consists of rock of smaller sizes than that used by lake trout (King and Swanson, pers. comm. 1979; Organ et al. 1978). Fry tend to swarm around docks along shore (Eddy and Underhill 1974). The decline of many lake whitefish stocks has been attributed to loss of spawning habitat caused by deposition of lumbering wastes (Lawrie and Rahrer 1973).

Minnesota

Spawning occurred along the Minnesota North Shore from the end of October through the third week of November (Minn. DNR 1937-59). Lake whitefish preferred a substrate of sand, clay, or gravel for spawning, and were less discriminating than lake trout (Kaups 1978). Known spawning areas are limited to the extreme northern and southern parts of the shore.

M-1

Sucker Bay (46°55', 91°50'). This was a spawning or feeding ground, where lake whitefish were abundant in about 1867 (Tomlin 1887a).

M-3

Pigeon Bay (48°01', 89°31'). The inshore areas are spawning and nursery areas (Hassinger, pers. comm. 1979). Fish were caught during the spawning season at the mouth of the Pigeon River (48°00', 89°34') (Henderson, pers. comm. 1979).

Wauswaugoning Bay (47°58', 89°37'). The inshore waters of the bay are spawning and nursery areas (Hassinger, pers. comm. 1979). A commercial fisherman, who fished off St. Frances Island at the north side of the bay mouth (47°58', 89°37'), reported that lake whitefish moved into the bay on about November 10 and remained for only a couple of days (Hendrickson, pers. comm. 1979).

Grand Portage Bay (47°57', 89°40'). This is a spawning and nursery area (Hassinger, pers. comm. 1979). Fishing began in the bay during November 1-15, and the fish left the bay by November 20-25. Nets were fished at the mouth of the bay at Grand Portage Island (47°57', 89°40') for spawning lake whitefish; 21 million eggs were collected on one occasion for hatchery use (Spry, pers. comm. 1979). Small lake whitefish were also caught west of the island (Hendrickson, pers. comm. 1979).

Wisconsin

Except for Brule Point Reef (46°46', 91°33'), the only known spawning grounds in Wisconsin waters are in the Apostle Islands region (47°00', 90°40'), where spawning occurs during approximately the second and third weeks of November (Coberly and Horrall 1980b, King and Swanson, pers. comm. 1979). One fisherman reports spawning occurred along the breakwalls off the mouth of the Nemadji River (46°42', 92°02'), and alongshore to the mouth of the Amnicon River (46°41', 91°51'), where he collected spent fish over the sand and gravel substrate in early December (Coberly and Horrall 1980b). Schools of adults move to shallows and shoal areas in the Apostle Island area to spawn (Dryer 1966); they often spawned on shallower portions of the same reefs that were used for spawning by lake trout (Coberly and Horrall 1980b). Probably most rocky areas along shore and throughout the Apostle Islands are used for spawning (King, pers. comm. 1979). Discrete spawning populations may exist within the Apostle Islands (King and Belonger 1970). The following areas have been identified as spawning or nursery grounds:

Superior Harbor (46°42', 92°01'). In 1886, large numbers of young lake whitefish were observed at the entrance to Allouez Bay (46°41', 92°00') (Tomlin 1887b).

Brule Point Reef (46°46', 91°33') (Coberly and Horrall 1980b).

Bark Point (46°53', 91°11') (King and Swanson, pers. comm. 1979).

Bark Bay (46°52', 91°10'), Siskiwit Bay (46°52', 91°07'), and Squaw Bay (46°53', 91°03') (Coberly and Horrall 1980b).

Eagle Island Shoals (46°55', 91°03') (Coberly and Horrall 1980b; King and Swanson, pers. comm. 1979).

Eagle Island (46°56', 91°02') (Coberly and Horrall 1980b).

Sand Island (46°59', 90°57'), Sand Island Shoals (47°00', 90°54'), York Island Shoals (47°01', 90°51'), and Bear Island Shoal (47°02', 90°49') (Coberly and Horrall 1980b; King and Swanson, pers. comm. 1979).

Bear Island (47°01', 90°45') (King and Swanson, pers. comm 1979).

Rocky Island (47°02', 90°41') (Dryer 1964; King and Swanson, pers. comm. 1979). Identified as one of the most productive spawning grounds (Coberly and Horrall 1980b).

South Twin Island (47°02', 90°39') (Coberly and Horrall 1980b).

North Twin Island (47°04', 90°35') (Coberly and Horrall 1980b; King and Swanson, pers. comm. 1979).

Otter Island (47°00', 90°41'), Oak Island (46°56', 90°44'), Oak Island Shoal (46°58', 90°43'), Little Manitou Island (46°58', 90°41'), and Ironwood Island (47°00', 90°37') (Coberly and Horrall 1980b).

Cat Island and Cat Island Reef (47°02', 90°33') (Coberly and Horrall 1980b; Dryer 1964).

Outer Island Shoal (47°05', 90°25') (Coberly and Horrall 1980b; Dryer 1964; King and Swanson, pers. comm. 1979).

Outer Island Reef (47°05', 90°25'), Presque Isle Point (46°55', 90°33'), Trout Point (46°58', 90°31'), South Trout Point (46°57', 90°30'), Quarry Bay Point (46°55', 90°35'), Hermit Island (46°53', 90°41'), and Basswood Island (46°50', 90°45') (Coberly and Horrall 1980b).

Michigan Island (46°53', 90°29') (King and Swanson, pers. comm. 1979). South end and shoal (46°54', 90°27') (Coberly and Horrall 1980b).

Madeline Island Reef (46°51', 90°33') (Coberly and Horrall 1980b; King and Swanson, pers. comm. 1979). Spawning occurs over sand, rubble, and rocks up to several feet in diameter (Nourse, pers. comm. 1979).

Madeline Island Buoy (46°45', 90°48'), head of Big Bay (46°49', 90°40'), Big Bay Point (46°44', 90°39'), Van Tassells Point (46°46', 90°52'), Houghton Point (46°42', 90°51'), Soldiers Rock (46°45', 90°45'), Schoolhouse Road west (46°50', 90°37'), Schoolhouse Road east (46°50', 90°36'), Chequamegon Bay (46°40', 90°50'), Sand Cut Reef (46°44', 90°41'), and Marble Point (46°35', 90°30') (Coberly and Horrall 1980b).

Michigan

MS-1

Isle Royale (48°00', 88°50'). Spawning occurred in many small areas, over rock and gravel; records of spawning in these areas date back to the early 1900s. The areas are off McCargoe Cove (48°06', 88°41'), Little Siskiwit Island (47°57', 88°53'), Wright Island (47°58', 88°49') and east to Schooner Island (47°49', 88°45'), at Point Houghton (47°54', 88°54'), at McCormick Reef (47°51', 89°02'), and at Washington (47°54', 89°11') and Grace (47°53', 89°13') harbors. Spawning occurred in these areas in 6-8 ft of water during late October to mid-November (Organ et al. 1978). Young were seined along shore all around the island, and in 1905 one fry, 1 3/4 in. long, was collected at the head of Tobin Harbor (48°09', 88°30') in late July (Hubbs and Lagler 1947).

MS-3

Keweenaw Peninsula (47°10', 88°30'). Rock-bottomed spawning grounds occur all around the peninsula, including areas just off Redridge (47°09', 88°46') and the Graveraet River (47°07', 88°51'), the shoal just north of the north waterway entry (47°14', 88°38'), Hutchinson Shoal (47°23', 88°24') (Wilson, pers. comm. 1979), Five Mile Point (47°23', 88°22') to Eagle River Shoals (47°26', 88°18') and Great Sand Bay (47°26', 88°15') since 1916 (Organ et al. 1978; Wilson, pers. comm. 1979), all around Manitou Island (47°25', 87°37') since 1916, three scattered areas between Keweenaw Point (47°24', 87°43') and Bete Grise Bay (47°23', 87°56') since 1974, the large shoal area on the north side of Grand Traverse Bay (47°12', 88°12'), and a rock and gravel trench (47°08', 88°08') about 5 mi off shore from Traverse Point (47°08', 88°14') since 1916 (Organ et al. 1978).

Keweenaw Bay (46°58', 88°20'). Rock shoals of Traverse Island (47°04', 88°16') have been used for spawning since 1916; spawning has also occurred at a rock and gravel shoal area about 100 ft deep at 47°03', 88°13' and at sand-bottomed areas in Pequaming Bay (46°50', 88°24'), and Sand Bay (46°52', 88°22') since 1929 (Organ et al. 1978). Spawning grounds at Pequaming (46°51', 88°24') and Baraga (46°47', 88°29') were destroyed by sawdust and mill waste by 1887 (MSBFC 1887).

Huron Bay (46°55', 88°10'). Rock areas of Point Abbaye Reef (46°58', 88°06') and the Huron Islands (46°57', 87°59') were used for spawning since 1916 (Organ et al. 1978; Wilson, pers. comm. 1979). The bay was a very important ground (MSBFC 1895).

Huron River Point (46°55, 87°54')--Salmon Trout Point (46°52', 87°44'). All of the rocky points in this area, including Huron River (46°55', 88°02'), Pine River (46°53', 87°52'), and Conway (46°52', 87°47') and Salmon Trout (46°52', 87°44') points, have been used since 1916 (Organ et al. 1978). Young-of-the-year whitefish were reported along shore in Pine River Bay (46°53', 87°51') (Hubbs 1929).

MS-4

Big Bay Point (46°51', 87°41'). Spawning occurred here since 1916 (Organ et al. 1978).

Marquette (46°33', 87°23'). No spawning grounds were known in this area, except those at "Standard" (Stannard) Rock (47°11', 87°14'), where limited amounts of spawn were collected (Smith and Snell 1891). Lake whitefish spawn in Presque Isle Harbor (46°34', 87°23'), over the rocks of the intake and discharge structures of the Presque Isle Power Station. Adults move into the harbor in November and December, and larvae were collected during April to mid-May (Wapora 1976a,b). Eggs were collected from the stomachs of fish in the harbor (FWS 1979d).

Munising (46°25', 86°39'). The entire area between Shot Point (46°30', 87°10') and Grand Portal Point (46°33', 86°28'), including Shelter Bay (46°29', 86°56'), Au Train Bay (46°27', 86°50'), Wood Island (46°31', 86°44'), and Grand Island (46°30', 86°40') is a major spawning ground. The area from Au Train Point (46°29', 86°48') to Powell Point (49°26', 86°40'), is a fishing ground and probably also a spawning ground (Swedberg and Nourse, pers. comm. 1979). The bay (probably South Bay 46°25', 86°39') was closed to fishing during the mid-1930s to protect spawning fish (Van Oosten 1938b). A local population still exists and probably spawns here (Organ et al. 1978; Swedberg, pers. comm. 1979). Spawning also occurred on November 15-30 along the east shore of Grand Island (Van Oosten 1927a).

MS-5

Au Sable Point (46°40', 86°09')--Crisp Point (46°45', 85°16'). Lake whitefish spawn along this entire shoreline, primarily over gravel in about 3-18 ft of water (Organ et al. 1978).

MS-6

Crisp Point (46°45', 85°16')--Whitefish Point (46°46', 84°57'). Spawning occurs here over gravel in 3-18 ft of water (Organ et al. 1978). Whitefish Point is an historical spawning site (Goodier, pers. comm. 1979). In 1913, a few young, 2-4 in. long, were seined in less than 3 ft of water over a sand bottom of Whitefish Point (Hankinson 1914).

Whitefish Bay (46°40', 84°50'). Spawning occurred in the bay during late October to mid-December, but primarily in November (Organ et al. 1978; Van Oosten 1927a). Spawning sites include Tahquamenon Island (46°32', 84°57'), and the shoals from Tahquamenon Island to Salt Point (46°28', 84°52'), High Banks (location unknown), Pendills Bay (46°28' 84°50'), and Iroquois Shoal (46°30', 84°40') (FWS 1979d; Gleason and Behmer, pers. comm. 1979; Organ et al. 1978; Van Oosten 1927a).

Ontario

OS-2

Black Bay (48°40', 88°30'). Eggs were collected from ripe fish in the bay (Rodd 1917).

OS-3

Nipigon River (48°57', 88°15'). The best fishing here was during the spawning season, in October, when lake whitefish moved inshore from deep water and schooled on sand and gravel shoals (MacDonald 1978; Milner 1874a).

OS-5

Terrace Bay (48°46', 87°10'). Lake whitefish spawn over sand at the back of Terrace Bay (Goodier, pers. comm. 1979).

OS-6

Michipicoten River (47°56', 84°51'). Lake whitefish ran into the lower river below the falls and rapids to spawn and were captured there in seines (Barnston 1874; Goode 1884; Milner 1874a).

OS-7

Gargantua (47°35', 84°58'). A fishery "preserve" in the Gargantua area was one of the best spawning grounds in the lake (Ont. Game Fish 1911).

Agawa Bay (47°21', 84°39'). Lake whitefish spawn in the bay was destroyed by suckers (Ont. Game Fish 1912).

Whitefish Bay (46°40', 84°50'). Historical spawning grounds existed throughout Whitefish Bay including the area along the shore from Batchawana Bay (46°51', 84°30') to the St. Marys River (46°30', 84°37'). Specific locations included the area between North and South Sandy islands (46°49', 84°39'), the east side of Ile Parisienne (46°40', 84°43'), (Goodier, pers. comm. 1979). The best fishing ground in the lake was considered to be Persian Island (probably Ile Parisienne), located 30 mi from Sault Ste. Marie (46°30', 84°21') and within 4 mi of the international boundary (Ont. Game Fish 1912). A stock in the lower part of the bay ran into the St. Marys River to spawn (Goodier, pers. comm. 1979; Lawrie and Rahrer 1972, 1973).

BLOATER

The early literature reports that bloaters in Lake Superior may have spawned nearshore in November and December (Eddy and Underhill 1974; Koelz 1929; Lagler 1948). Ripe adults were not seen in catches and the spawning grounds were unknown (Koelz 1929).

Minnesota

Bloaters are believed to spawn on the offshore banks along the entire shore. Ripe adults are caught by fishermen in these areas in the spring (Hassinger, pers. comm. 1979).

Wisconsin

Apostle Islands (47°00', 90°40'). Ripe, spawning chubs, possibly bloaters, are found throughout the islands (Swanson, pers. comm. 1979). Although ripe individuals are found throughout the year, the occurrence of spent fish suggests most spawning takes place in February and March; spent fish were also observed in September. Ripe and spent fish were taken at depths of 120-300 ft and over all bottom types (Dryer and Beil 1968). Spawning occurred during the 1960s in a 350-375 ft deep trench between Stockton Island (46°56', 90°35') and Michigan Island (46°53', 90°29'); an occasional ripe fish is found there in early December and peak spawning is believed to occur in January and February (Pycha, pers. comm. 1979).

Michigan

MS-4

Marquette (46°33', 87°23'). In December 1976, four ripe males and four ripe females were collected at depths of about 425-490 ft, 10 mi NE of Marquette (Passino and Kramer 1980).

KIYI

The kiyi is generally common in deep waters of Lake Superior, but its numbers are declining and it is listed as a "threatened" species. The kiyi is probably extinct elsewhere in the Great Lakes (Todd, pers. comm. 1981). The kiyi spawns in late October to early December (Eddy and Underhill 1974; Koelz 1929; Lagler 1948; Scott and Crossman 1973).

Wisconsin

Apostle Islands (47°00', 90°40'). During the early 1960s, the kiyi spawned in a 350-375 ft deep trench between Stockton Island (46°56', 90°35') and Michigan Island (46°53', 90°29') (Pycha, pers. comm. 1979).

Michigan

MS-4

Granite Island (46°43', 87°25'). Kiyi spawned off the island at a depth of 420 ft. In 1922, fish collected on November 22 were nearly ripe and most were spawning or spent on December 5 (Koelz 1929).

BLACKFIN CISCO

The blackfin cisco is believed to be extinct in the Great Lakes (Todd, pers. comm. 1981). In Lake Superior, this species spawned in September and early October at depths of 360-600 ft (Koelz 1929; Van Oosten 1938b).

Michigan

MS-5

Grand Marais (46°40', 85°59'). The species was most abundant here in September. In early October 1917, pearled males and ripe, spawning, and spent females were found here at depths of 390 ft (Koelz 1929).

Ontario

OS-3

Rossport (48°50', 87°31'). In 1921, pearled males and ripe, spawning, and spent females were found here at depths of 480-540 ft on October 4 (Koelz 1929).

SHORTNOSE CISCO

The shortnose cisco is believed to be extinct in Lake Superior. A small population in Georgian Bay (45°30', 81°00'), Lake Huron, is the only remaining population in the Great Lakes (Todd, pers. comm. 1981).

Spawning probably occurred in November on sand or mud bottom at depths of 250 ft or less (Eddy and Underhill 1974; Lagler 1948).

Minnesota

In 1942, eggs of an unidentified cisco were collected for hatchery use along the Minnesota North Shore during November 3-11 (Minn. DNR 1937-59); the time of collection coincided generally with the assumed spawning period of the shortnose cisco.

Ontario

OS-1

Thunder Bay (48°25', 89°00'). Spawning may have occurred in November, because most females collected in late November 1922 were spent (Koelz 1929).

SHORTJAW CISCO

The shortjaw cisco occurs in moderate numbers in Lake Superior, however, its numbers are greatly reduced, and it should be considered a "threatened" species (Todd, pers. comm. 1981). The shortjaw cisco is now considered to be taxonomically synonymous with the longjaw cisco (Todd and Smith, unpubl. data). Spawning occurs in late November-early December at depths of 120-240 ft over clay bottom (Van Oosten 1937b).

Minnesota

M-3

Grand Marais (47°45', 90°20'). Spawning may have occurred here along shore; large catches were made here in November (Koelz 1929).

Michigan

MS-4

Marquette (46°33', 87°23'). Large catches of spawners were made about 10 mi NW of Marquette (the approximate location of Granite Island, 46°43', 87°25') over a clay bottom at depths of 120-240 ft. In 1922, the run lasted about 1 week in late November-early December (Koelz 1929). Laughing Fish Point (46°32', 87°01') and Au Train Reef (46°30', 86°54'). In 1916, catches were made here in early November (Anderson 1920-26).

MS-5

Grand Marais (46°40', 85°59'). In 1963, eggs and sperm were stripped from ripe fish caught 7 1/2 mi off Grand Marais in mid-May; the fertilized eggs hatched to produce viable fry (Edsall, pers. comm. 1980).

CISCO spp.

Michigan

MS-2

Ontonagon (46°53', 89°19'). Spawning occurred in a 210-240 ft deep trench running offshore approximately from Union Bay (46°50', 89°37') to Misery Bay (47°00', 89°01') over a bottom of mud and rock (Wilson, pers. comm. 1979).

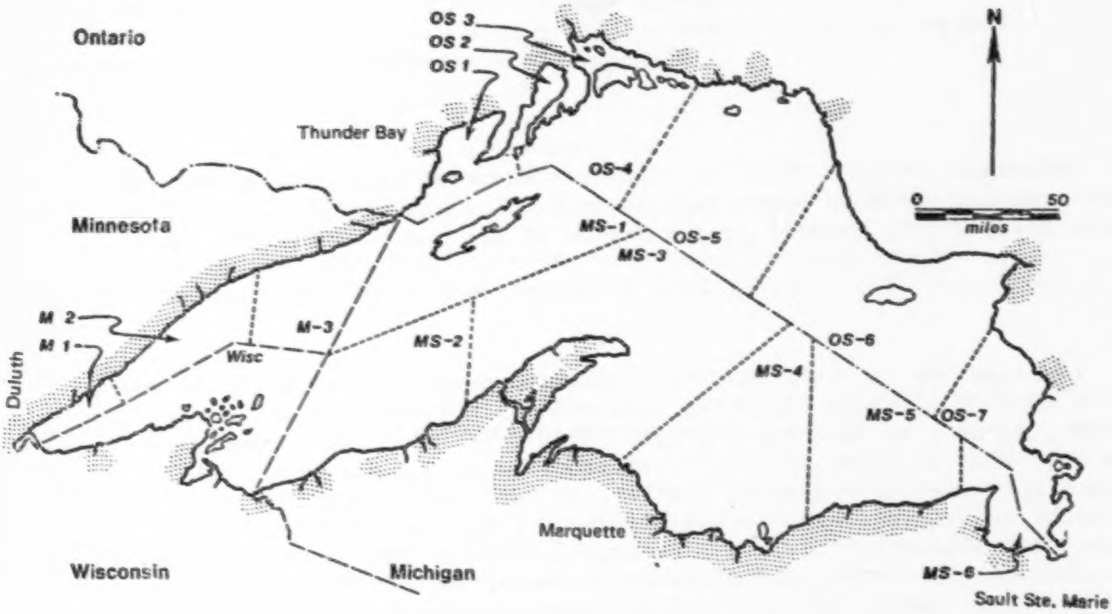
MS-3

Keweenaw Bay (46°58', 88°20'). Spawning occurs in a 200-250 ft deep trench running offshore along the east side of the bay from Pt. Abbaye (46°58', 88°08') to Sand Bay (46°52', 88°22') (Wilson, pers. comm. 1979). From the 1920s to 1959, spawning also occurred in a small area (46°52', 88°24') northwest of Pequaming (46°51', 88°24') during November over mud at depths greater than 300 ft and off the Assinins Keweenaw Bay Tribal Center (46°49', 88°28') over mud at depths of more than 100 ft. Spawning also occurred in October and November at depths of more than 300 ft over hard clay and rock in the area bounded by Pt. Isabelle (47°21', 87°56'), Grand Traverse Bay (47°11', 88°13'), and Big Bay (46°50', 87°43') (Organ et al. 1978).

MS-5

Grand Marais (46°40, 85°59'). Since 1974, spawning has occurred off Grand Marais at 46°48', 86°00'--46°50', 85°43' over rock at depths of 300-656 ft (Organ et al. 1978).

PINK SALMON


Ontario
OS 3
OS 2
OS 1
Thunder Bay
OS-4
N
0
50
miles
Minnesota
MS-1
OS-5
MS-3
M 2
M 1
M-3
MS-2
Wisc
Duluth
D
OS-6
MS-4
MS-5
OS-7
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie

Since this species was accidentally released into Canadian waters of Lake Superior in 1956, runs have developed in almost every tributary in the lake (Kwain and Chappel 1978; Parsons 1973; Smith 1978c; Tait 1973). Spawning occurred usually only in odd-numbered years (Wagner 1978a), but in 1976 an even-year run developed (Kwain and Chappel 1978), and 3-year-old spawners have been captured in three streams (Wagner and Stauffer 1980). Pink salmon first appear in tributaries in early September, and runs usually peak by mid-September (Rybicki 1973).

Minnesota

The first pink salmon run occurred in 1959 (Hassinger, pers. comm. 1979), and in 1979 they were probably successfully reproducing in all North Shore streams (H. Johnson, pers. comm. 1979). The adults are not seen in the lake until they begin to congregate off stream mouths in fall. The young-of-the-year (YOY) drift into the lake immediately after hatching and have not been collected in the lake (Hassinger, pers. comm. 1979). Runs occur in the following tributaries:

M-1

Big Sucker Creek (Sucker River) (46°55', 91°51'). Some of the first pink salmon taken in the Lake Superior drainage were caught in the river mouth in September 1959 (Eddy and Underhill 1974; Schumacher and Eddy 1960; Schumacher and Hale 1962).

French River (46°54', 91°53'). Successful reproduction occurs. Even-year runs were observed in 1978 (H. Johnson, pers. comm. 1979).

M-2

Cascade River (47°42', 90°31'). Spawning was observed (Eddy and Underhill 1974).

Poplar River (47°38', 90°42'). Spawners were present on redds in mid-September 1961 (Parsons 1973; Schumacher and Hale 1962).

Cross River (47°32', 90°53'). Some of the first pink salmon taken in the Lake Superior drainage were caught in the river mouth in September 1959 (Eddy and Underhill 1974; Schumacher and Eddy 1960; Schumacher and Hale 1962); adults were found in the river in late September 1963 (Moore and Braem 1965).

M-3

Pigeon River (48°00', 89°34') (Hassinger, pers. comm. 1979; Nunan 1967; OMNR 1976b).

Wisconsin

Runs of pink salmon occur in almost every Wisconsin tributary to Lake Superior (Schram, pers. comm. 1979).

Brule River (46°45', 91°37'). A run occurs in early October (Schram, pers. comm. 1979).

Sioux River (46°44', 90°52'). A run enters the Little Sioux River, a tributary of the Sioux River, in late August-September (Nourse, pers. comm. 1979; Swanson and King, pers. comm. 1979).

Fish Creek (46°35', 90°57'). A run occurs in late August-September (Swanson and King, pers. comm. 1979).

Montreal River (46°34', 90°25'). A run was first reported in 1975 (Wagner 1976a,b).

Michigan

Pink salmon congregate off river mouths in mid-late August, run upstream to spawn in early to mid-September, and spend 3-5 days in the stream. Spent fish usually leave the tributaries by mid-October (North Woods Call 1979h,l; Wagner and Stauffer 1975). Spawning usually occurs where fish encounter the first suitable area of gravel; however, in the Sturgeon River (47°02', 88°29'), fish migrated 40-50 mi upstream until stopped by a dam (Wagner 1976a,b; Wagner and Stauffer 1975). Runs occur in the following streams:

MS-2

Black River (46°40', 90°03') and Presque Isle River (46°43', 89°58') (Richey 1976; Smith 1978a; Wagner 1974a, 1976a,b, 1977, 1978a, 1979; Wagner and Stauffer 1975).

Potato River (46°51', 89°23'). First run in 1977 (Wagner 1978a).

Fire Steel River (46°56', 89°12'). First run in 1979 (Wagner 1979).

Misery River (47°00', 88°59'). First run in 1975 (Wagner 1976a,b, 1979).

MS-3

Elm River (47°03', 88°55') (Richey 1976; Wagner 1974a, 1976a,b, 1977, 1978a, 1979; Wagner and Stauffer 1975).

Graveraet River (47°07', 88°51'). First run in 1975 (Wagner 1976a,b).

Salmon Trout River (47°09', 88°46') and Schlot (Schlotz) Creek (47°11', 88°39'). First run in 1975 (Wagner 1976a,b, 1979).

Boston-Lily Creek (47°11', 88°38') and Pilgrim River (47°06', 88°31'). First run in 1979 (Wagner 1979).

Gratiot River (47°21', 88°27'). First run in 1975 (Wagner 1976a,b, 1977, 1979).

Fanny Hooe Creek (47°28', 87°52'). The first run occurred in 1975 (Wagner 1976a,b, 1977, 1979). In mid-September 1979, pink salmon blanketed the bottom of the stream; most spawned below the falls within "casting distance" of the lake (North Woods Call 1979l).

Little Gratiot River (47°22', 88°02'). First run in 1979 (Wagner 1979).

Tobacco River (47°14', 88°09'). First run in 1975 (Wagner 1976a,b, 1979).

Traverse River (47°11', 88°14'). First run in 1975 (Wagner 1976a,b, 1979; Wagner and Stauffer 1975).

Trap Rock River (47°11', 88°24'). First run in 1975 (Wagner 1976a,b, 1979).

Sturgeon River (47°02', 88°29'). A very heavy run occurred in 1975 (Richey 1976; Wagner 1974a, 1976a,b, 1979; Wagner and Stauffer 1975).

Kelsey Creek (46°53', 88°28'). First run in 1979 (Wagner 1979).

Six Mile Creek (46°45', 88°30'). First run in 1975 (Wagner 1976a,b, 1977).

Falls River (46°45', 88°27'). Very heavy runs occur (Richey 1976; Wagner 1974a, 1976a,b, 1977, 1979; Wagner and Stauffer 1975).

Silver River (46°49', 88°17'). First run in 1975 (Richey 1976; Wagner 1974a, 1977, 1979; Wagner and Stauffer 1975).

Slate River (46°50', 88°16') and Ravine River (46°50', 88°15'). First run in 1975 (Richey 1976; Wagner 1976a,b, 1979).

Big Huron River (46°55', 88°02'). Very heavy runs occur (Richey 1976; Smith 1978a; Wagner 1974a, 1976, 1977, 1979; Wagner and Stauffer 1975, 1980).

Little Huron River (46°54', 88°00'). First run in 1975 (Richey 1976; Wagner 1976, 1977, 1979).

Salmon Trout River (46°52', 87°46'). First run in 1977 (Wagner 1977, 1979).

MS-4

Little Iron River (46°49', 87°39'). A spawning pair of pink salmon was observed on September 25, 1967 (Richey 1976; Wagner 1974a; Wagner and Stauffer 1975).

Big Garlic River (46°43', 87°34'). First run in 1975 (Wagner 1976, 1979).

Little Garlic River (46°41', 87°31'). First run in 1975 (Wagner 1976, 1977, 1979).

Harlow Creek (46°38', 87°28') (Richey 1976; Smith 1978a; Wagner 1974a, 1976, 1977, 1978a, 1979; Wagner and Stauffer 1975, 1980).

Dead River (46°34', 87°23') (FWS 1979d; Richey 1976; Wagner 1974a, 1976, 1978a, 1979; Wagner and Stauffer 1975; Wapora 1976b). Spawning occurs in mid-September at 60°F and is probably successful (Berg 1976).

Carp River (46°31', 87°23') (Wagner 1974a, 1976, 1977, 1979; Wagner and Stauffer 1975).

Chocolay River (46°30', 87°21') (Richey 1976; Smith 1978a; Wagner 1974a, 1976, 1977, 1978a, 1979; Wagner and Stauffer 1975). Even-year spawning was first observed here in 1976 (Wagner 1977, 1978c).

Sand River (46°30', 87°06'). First run in 1975 (Wagner 1976).

Laughing Whitefish River (46°31', 87°02'). Very heavy runs occur (Richey 1976; Wagner 1974a, 1976, 1977, 1979; Wagner and Stauffer 1975).

Rock River (46°28', 86°55') (Wagner 1977, 1979; Wagner and Stauffer 1975).

Furnace Creek (46°26', 86°42'). First run in 1977 (Wagner 1978a, 1979).

Anna River (46°25', 86°38') (Wagner 1974a; Wagner and Stauffer 1975).

Miners Creek (46°30', 86°33') (Wagner 1977, 1979).

MS-5

Seven Mile Creek (46°37', 86°16'). First run in 1977 (Wagner 1978a, 1979).

Sable Creek (46°40', 86°01'). First run in 1975 (Richey 1976; Wagner 1976, 1977, 1979).

Sucker River (46°40', 85°56') (Wagner 1978a, 1979).

Blind Sucker River (46°41', 85°40') (Wagner 1974a, 1976, 1977, 1979; Wagner and Stauffer 1975). In 1979, fish were seen at the mouth in mid-September (Schmidt 1979).

Big Two Hearted River (46°42', 85°25') (Wagner 1974a, 1977, 1979; Wagner and Stauffer 1975).

MS-6

Tahquamenon River (46°33', 85°02') (Wagner 1976, 1977, 1979; Wagner and Stauffer 1975).

Water Wheel Creek (46°28', 84°55'). First run in 1979 (Wagner 1979).

Pendills Creek (46°27', 84°49') (Gleason and Behmer, pers. comm. 1979; Wagner 1974a, 1976, 1979; Wagner and Stauffer 1975, 1980).

Ontario

Pink salmon congregate offshore before entering tributaries in mid-September. Runs last about 2 weeks (OMNR 1976b). Sizable runs were not observed until 1969, but by 1971, pink salmon were in every major tributary between the Nipigon River (48°57', 88°15') and the Pic River (48°36', 86°18'), except the Jackfish River (49°00', 88°05') (Gollat 1976). Runs occur in the following 22 tributaries (OMNR 1976b):

OS-1

Kaministiquia River (48°23', 89°13').

Current River (48°27', 89°11'). This is the site where pink salmon were first released in the Great Lakes.

MacKenzie River (48°32', 88°57'). One of the first very large runs occurred here in 1969.

OS-2

Wolf River (48°49', 88°29').

Black Sturgeon River (48°50', 88°24'). A ripe male was seen in Black Bay in early September 1961 (Nunan 1967).

OS-3

Nipigon River (48°57', 88°15'). A ripe male was seen here in late September 1961 (Nunan 1967).

Jackpine River (48°58', 88°00') and Gravel River (48°55', 87°46').

McKellar Creek (48°50', 87°28') and Hewitson River (48°50', 87°27').

OS-5

Schreiber Creek (48°46', 87°15').

Steel River (48°46', 87°54'). The first even-year run occurred here in late September to mid-October 1976 (Kwain and Chappel 1978).

Prairie River (48°47', 86°47'), Ripple Creek (48°47', 86°45'), Little Pic River (48°47', 86°38'), and Angler Creek (48°45', 86°25').

Pic River (48°36', 86°18'). Many adults were observed here in early to mid-September 1975 (Schleen 1975).

OS-6

Magpie River (47°58', 84°52').

Michipicoten River (47°56', 84°51'). An extremely large run occurred here in 1975; most adults present in the river on October 1-2 had completed spawning (Schleen 1975).

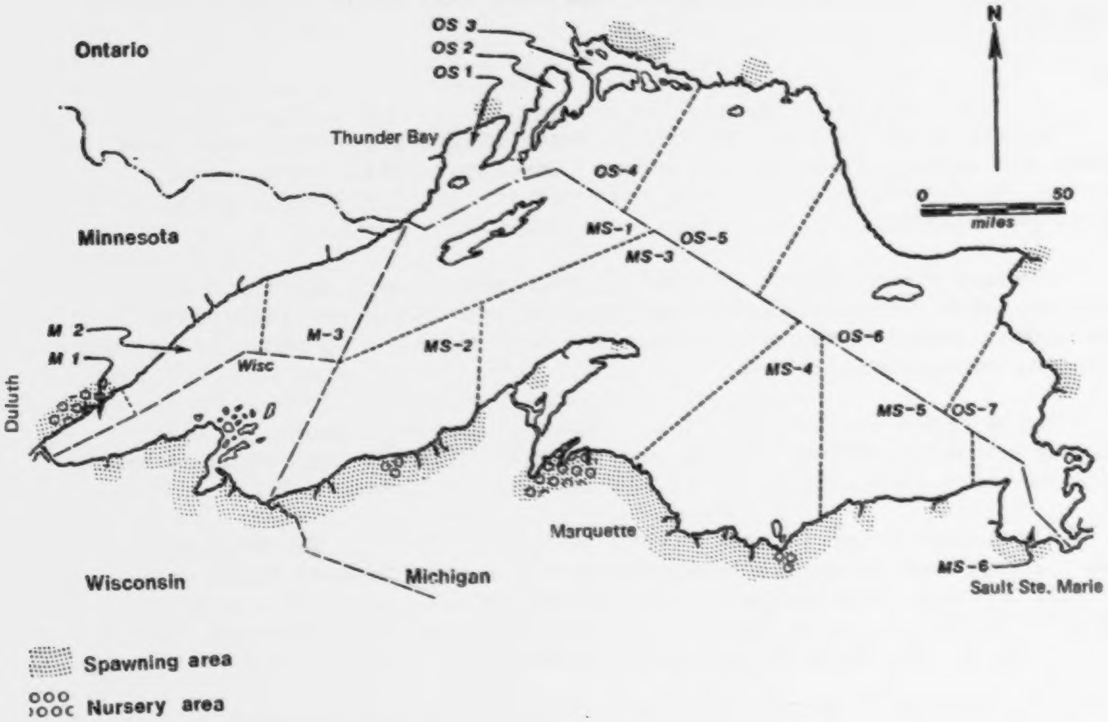
Old Woman River (47°47', 84°54').

OS-7

Agawa River (47°21', 84°38'). A large run entered the river in early September and most fish had finished spawning by mid-September (Schleen 1975).

Speckled Trout Creek (47°19', 84°36').

COHO SALMON


Ontario
OS 3
OS 2
OS 1
Thunder Bay
N
0
50
miles
Minnesota
OS-4
MS-1
OS-5
MS-3
M 2
M 1
M-3
MS-2
Wisc
Duluth
B
OS-6
MS-4
MS-5
OS-7
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie
Spawning area
Nursery area

Coho salmon planted in Lake Superior in 1966 (Parsons 1973) produced spawning runs in a number of Lake Superior tributaries and established self-sustaining populations in some areas.

Minnesota

Coho salmon have been planted in the Beaver River (47°15', 91°18'), Gooseberry River (47°08', 91°27'), Silver Creek (47°04', 91°36'), Stewart River (47°03', 91°38'), French River (46°54', 91°53'), and Grand Portage Creek (47°58', 89°41') (GLFC 1973a,b, 1975, 1976). Straying occurs, and in 1974, it was reported that coho salmon probably ran into most streams along the shoreline (Hassinger 1971a, 1974c). An offshore migration appears to occur from the western Wisconsin area, beginning in late May or early June, past the Duluth-Superior Harbor entry, and up the Minnesota shore. By early July, coho salmon are in the vicinity of the

Knife River (46°57', 91°47') (H. Johnson, pers. comm. 1979). Spawning occurs in October and November. Many Minnesota streams have impassable falls near the mouth which prevent the fish from moving upstream to suitable spawning habitat. The Devil Track (47°46', 90°15'), Baptism (47°20', 91°12'), and Brule (47°49', 90°03') rivers offer marginal habitat (Eddy and Underhill 1974). Spawning runs occur in the following streams:

M-1

Silver Creek (47°04', 91°36'). Young-of-the-year (YOY) have been found and natural reproduction occurs (Hassinger 1974c, pers. comm. 1979). No reproduction has been observed in recent years (H. Johnson, pers. comm. 1979).

Stewart River (47°03', 91°38'). Four adults were caught in late October and mid-November (Hassinger 1971a), and YOY were also found (Hassinger 1974c). No reproduction has been observed in recent years (H. Johnson, pers. comm. 1979).

Knife River (46°57', 91°47'). Seven adults were caught in late October to mid-November 1970 (Hassinger 1971a), but no reproduction has been observed in recent years (H. Johnson, pers. comm. 1979).

Big Sucker Creek (Sucker River) (46°55', 91°51'). Two adults and two "jacks" were caught in late September and late October (Hassinger 1971a); YOY were also collected (Hassinger 1974c). Natural reproduction occurs (Hassinger, pers. comm. 1979), but none has been observed in recent years (H. Johnson, pers. comm. 1979).

Schmidt Creek (46°54', 91°53'). Natural reproduction occurs (Hassinger, pers. comm. 1979), but none has been observed in recent years (H. Johnson, pers. comm. 1979).

French River (46°54', 91°53'). Movement into the stream is correlated with increased water flow and temperature greater than 40°F. The run begins during the first week of September and continues until freeze-up in the last week of November or first week of December, with peak returns in late October to late November (Hassinger 1970, 1971b, 1974c). Jacks usually enter the stream in October (Hassinger 1974c). Natural reproduction occurs (Hassinger, pers. comm. 1979), but none has been observed in recent years (H. Johnson, pers. comm. 1979).

Talmadge River (46°53', 91°55'). Adults were present in late October and early November (Hassinger 1971a), and YOY have been found (Hassinger 1974c). No reproduction has occurred in recent years (H. Johnson, pers. comm. 1979).

Lester River (46°50', 92°00'). Thirty adults were caught in late October (Hassinger 1971a), but no reproduction has occurred in recent years (H. Johnson, pers. comm. 1979).

Temperance River (47°33', 90°52'). One adult was caught in late September 1970 (Hassinger 1971a).

Cross River (47°32', 90°53'). One adult was caught in mid-October 1970 (Hassinger 1971a).

Split Rock River (47°11', 91°24'). One adult was caught in early November 1970 (Hassinger 1971a). This river offers marginal spawning habitat (Eddy and Underhill 1974).

Wisconsin

Coho salmon have not been stocked in Wisconsin tributaries, but spawning runs occur from early October into January (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979), and natural reproduction occurs in several streams (King and Swanson 1975).

Brule River (46°45', 91°37'), Flag River (46°47', 91°23'), Cranberry River (46°50', 91°16'), and Bark River (46°51', 91°11') (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979).

Siskiwit River (46°51', 91°06'). Possible run (Schram, pers. comm. 1979).

Onion River (46°45', 90°53') (King and Swanson, pers. comm. 1979).

Sioux and Little Sioux Rivers (46°44', 90°52'), and Thompson Creek (46°40', 90°55') (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979).

Bono Creek (46°38', 90°55'), and Whittlesey Creek (46°36', 90°57'). Fish Creek (46°35', 90°57'). Runs progress upstream to North Fish Creek and Pine Creek. Bad and White Rivers (46°38', 90°39'), and Graveyard Creek (46°35', 90°29') (King and Swanson, pers. comm. 1979).

Montreal River (46°34', 90°25') (King and Swanson, pers. comm. 1979). Spawning runs progress upstream to Superior Falls (Anderson and Threinen 1969).

Michigan

Coho salmon plantings were first made in 1966 in Chinks Creek, a tributary of the Huron River (46°55', 88°02') (Taube 1975; USDI 1970). Subsequently, plantings were made in the Black (46°40', 90°03'), Presque Isle (46°43', 89°58'), Ontonagon (46°52', 89°20'), Sturgeon (47°02', 88°29'), Falls (46°45', 88°27'), Huron (46°55', 88°02'), Dead (46°34', 87°23'), Anna (46°25', 86°38'), and Sucker (46°40', 85°56') rivers, and in Cherry Creek, a tributary of the Chocolay River (46°30', 87°21') (GLFC 1973a,b, 1975, 1976, 1978; MDNR 1970; Parsons 1973). Spawning runs occur in late September-late November, when the stream temperature drops to about 40°F (Miller and Scott 1967, as cited in Wapora 1976a). Runs usually peak in late October-early November (Hannuksela and Stauffer 1975). Straying occurs and runs have been noted in the following tributaries:

MS-2

Maple Creek (46°39', 90°07'), Black River (46°40', 90°03'), Presque Isle River (46°43', 89°58'), Little Carp River (46°45', 89°54'), and Carp River (46°46', 89°53') (MDNR 1970).

Union River (46°49', 89°37'). Natural reproduction occurs and YOY were present (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; MDNR 1970; Parsons 1973; Peck 1970; Stauffer 1969a,b, 1971c,d, 1973a, 1974a,b, 1975b, 1977).

Big Iron River (46°50', 89°34'), Fire Steel River (46°56', 89°12'), and Sleeping River (46°59', 89°04') (MDNR 1970).

MS-3

Elm River (47°03', 88°55'), McGunn's Creek (47°15', 88°33'), and Fanny Hooe Creek (47°28', 87°52') (MDNR 1970).

Falls River (46°46', 88°28') (MDNR 1970). Young-of-the-year were collected (Peck 1970).

Silver River (46°49', 88°17') (MDNR 1970). Young-of-the-year were collected (Peck 1970). A large run enters Kallio Creek (a tributary of Silver River), where spawning and redds were observed (Mich. Dep. Conserv. 1968b; Miller and Scott 1968).

Slate River (46°50', 88°16') and Ravine River (46°50', 86°15') (MDNR 1970).

Huron River (46°55', 88°02'). A run of naturally-recruited adults enters the river from mid-September to early December or later. Ripe adults and eggs were collected and redds were observed in the Huron River. Spawning was observed in late September to November in Chinks Creek, and YOY were found during June-November (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; Mich Dep. Conserv. 1968b; MDNR 1970; Miller and Scott 1968; Parsons 1973; Peck 1970; Rybicki 1973; Stauffer 1969a,b, 1971c,d, 1972b,c, 1973a,b, 1974a,b, 1975a,b, 1976a, 1977; Tody 1970; USBCF 1969b). Adults dispersed equally into the east and west branches (Miller and Scott 1968). Low water temperatures delayed spawning by some fish until spring (MDNR 1970).

Little Huron River (46°54', 88°00'). Self-sustaining runs occur (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; MDNR 1970; Parsons 1973; Peck 1970; Stauffer 1969a,b, 1971c,d, 1972b,c, 1973a,b, 1974a,b, 1975b, 1977).

Salmon Trout River (46°52', 87°46') (MDNR 1970).

MS-4

Little Iron River (46°49', 87°39'), and Big Garlic River (46°43', 87°34') (MDNR 1970).

Little Garlic River (46°41', 87°31'). Self-sustaining runs occur (Hannuksela 1978; Hannuksela and Stauffer 1975; Jenkins 1970, 1972; MDNR 1970; Peck 1970; Stauffer 1969a,b, 1971c,d, 1972b,c, 1973a,b, 1974a,b, 1975a,b, 1977).

Harlow Creek (46°38', 87°28') (MDNR 1970).

Dead River (46°34', 87°23'). A spawning run enters the Dead River, and the nearby discharge canal of the Presque Isle Power Station. The major run occurs in mid-September to November, several weeks after the chinook salmon run (Wapora 1976b). Spawning occurs during mid-September to early November at about 47-57°F, but is probably not successful because of unsuitable habitat (Berg 1976; Hannuksela and Stauffer 1975; Stauffer 1974b).

Carp River (46°31', 87°23') (MDNR 1970; Swedberg, pers. comm. 1979).

Chocolay River (46°30', 87°21') (MDNR 1970). Runs enter Cherry Creek, a tributary to the Chocolay River, beginning in late September and peak by mid-late October (Hannuksela and Stauffer 1975; Stauffer 1972b, 1973b, 1974b).

Sand River (46°30', 87°06'), Laughing Whitefish River (46°31', 87°02'), Rock River (46°28', 86°55'), Au Train River (46°26', 86°51'), and Furnace Creek (46°26', 86°42') (MDNR 1970).

Anna River (46°25', 86°38'). Self-sustaining runs occur in mid-September to mid-November at 40-50°F, and YOY have been found (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; Parsons 1973; Peck 1970; Stauffer, 1969a,b, 1971a,c,d, 1972b,c, 1973a,b,c, 1974a,b, 1975b, 1976a, 1977).

Miners Creek (46°30', 86°33') and Mosquito River (46°32', 86°30') (MDNR 1970).

MS-5

Seven Mile Creek (46°37', 86°16') (MDNR 1970).

Sucker River (46°40', 85°56') (MDNR 1970; Rybicki 1973).

Big Two Hearted River (46°42', 85°25') (MDNR 1970).

87°23'), Anna (46°25', 86°38'), and Sucker (46°40', 85°56') rivers, and in Cherry Creek, a tributary of the Chocolay River (46°30', 87°21') (GLFC 1973a,b, 1975, 1976, 1978; MDNR 1970; Parsons 1973). Spawning runs occur in late September-late November, when the stream temperature drops to about 40°F (Miller and Scott 1967, as cited in Wapora 1976a). Runs usually peak in late October-early November (Hannuksela and Stauffer 1975). Straying occurs and runs have been noted in the following tributaries:

MS-2

Maple Creek (46°39', 90°07'), Black River (46°40', 90°03'), Presque Isle River (46°43', 89°58'), Little Carp River (46°45', 89°54'), and Carp River (46°46', 89°53') (MDNR 1970).

Union River (46°49', 89°37'). Natural reproduction occurs and YOY were present (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; MDNR 1970; Parsons 1973; Peck 1970; Stauffer 1969a,b, 1971c,d, 1973a, 1974a,b, 1975b, 1977).

Big Iron River (46°50', 89°34'), Fire Steel River (46°56', 89°12'), and Sleeping River (46°59', 89°04') (MDNR 1970).

MS-3

Elm River (47°03', 88°55'), McGunn's Creek (47°15', 88°33'), and Fanny Hooe Creek (47°28', 87°52') (MDNR 1970).

Falls River (46°46', 88°28') (MDNR 1970). Young-of-the-year were collected (Peck 1970).

Silver River (46°49', 88°17') (MDNR 1970). Young-of-the-year were collected (Peck 1970). A large run enters Kallio Creek (a tributary of Silver River), where spawning and redds were observed (Mich. Dep. Conserv. 1968b; Miller and Scott 1968).

Slate River (46°50', 88°16') and Ravine River (46°50', 86°15') (MDNR 1970).

Huron River (46°55', 88°02'). A run of naturally-recruited adults enters the river from mid-September to early December or later. Ripe adults and eggs were collected and redds were observed in the Huron River. Spawning was observed in late September to November in Chinks Creek, and YOY were found during June-November (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; Mich Dep. Conserv. 1968b; MDNR 1970; Miller and Scott 1968; Parsons 1973; Peck 1970; Rybicki 1973; Stauffer 1969a,b, 1971c,d, 1972b,c, 1973a,b, 1974a,b, 1975a,b, 1976a, 1977; Tody 1970; USBCF 1969b). Adults dispersed equally into the east and west branches (Miller and Scott 1968). Low water temperatures delayed spawning by some fish until spring (MDNR 1970).

Little Huron River (46°54', 88°00'). Self-sustaining runs occur (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; MDNR 1970; Parsons 1973; Peck 1970; Stauffer 1969a,b, 1971c,d, 1972b,c, 1973a,b, 1974a,b, 1975b, 1977).

Salmon Trout River (46°52', 87°46') (MDNR 1970).

MS-4

Little Iron River (46°49', 87°39'), and Big Garlic River (46°43', 87°34') (MDNR 1970).

Little Garlic River (46°41', 87°31'). Self-sustaining runs occur (Hannuksela 1978; Hannuksela and Stauffer 1975; Jenkins 1970, 1972; MDNR 1970; Peck 1970; Stauffer 1969a,b, 1971c,d, 1972b,c, 1973a,b, 1974a,b, 1975a,b, 1977).

Harlow Creek (46°38', 87°28') (MDNR 1970).

Dead River (46°34', 87°23'). A spawning run enters the Dead River, and the nearby discharge canal of the Presque Isle Power Station. The major run occurs in mid-September to November, several weeks after the chinook salmon run (Wapora 1976b). Spawning occurs during mid-September to early November at about 47-57°F, but is probably not successful because of unsuitable habitat (Berg 1976; Hannuksela and Stauffer 1975; Stauffer 1974b).

Carp River (46°31', 87°23') (MDNR 1970; Swedberg, pers. comm. 1979).

Chocolay River (46°30', 87°21') (MDNR 1970). Runs enter Cherry Creek, a tributary to the Chocolay River, beginning in late September and peak by mid-late October (Hannuksela and Stauffer 1975; Stauffer 1972b, 1973b, 1974b).

Sand River (46°30', 87°06'), Laughing Whitefish River (46°31', 87°02'), Rock River (46°28', 86°55'), Au Train River (46°26', 86°51'), and Furnace Creek (46°26', 86°42') (MDNR 1970).

Anna River (46°25', 86°38'). Self-sustaining runs occur in mid-September to mid-November at 40-50°F, and YOY have been found (Hannuksela and Stauffer 1975; Jenkins 1970, 1972; Parsons 1973; Peck 1970; Stauffer, 1969a,b, 1971a,c,d, 1972b,c, 1973a,b,c, 1974a,b, 1975b, 1976a, 1977).

Miners Creek (46°30', 86°33') and Mosquito River (46°32', 86°30') (MDNR 1970).

MS-5

Seven Mile Creek (46°37', 86°16') (MDNR 1970).

Sucker River (46°40', 85°56') (MDNR 1970; Rybicki 1973).

Big Two Hearted River (46°42', 85°25') (MDNR 1970).

MS-6

Halfaday Creek (46°28', 84°54') and Grants Creek (46°28', 84°52') (MDNR 1970).

Pendills Creek (46°27', 84°49') (MDNR 1970; Gleason and Behmer, pers. comm. 1979).

Ontario

Spawning runs occur in September-November (OMNR 1976b) in every major tributary between the Nipigon River (48°57', 88°15') and the Pic River (48°36', 86°18'), except the Jackfish River (49°00', 88°05') (Gollat 1976). Runs occur in some years in the following streams (OMNR 1976b):

OS-1

MacKenzie River (48°32', 88°57'). Adults have been seen in mid-September at the mouth of the river (Tibbles 1979).

OS-3

Jackpine River (48°58', 88°00').

Gravel River (48°55', 87°46'). In 1971, the coho salmon run here exceeded the rainbow trout run (Gollat 1976).

OS-5

Steel River (48°46', 87°54'). In 1971, the coho salmon run here exceeded the rainbow trout run (Gollat 1976).

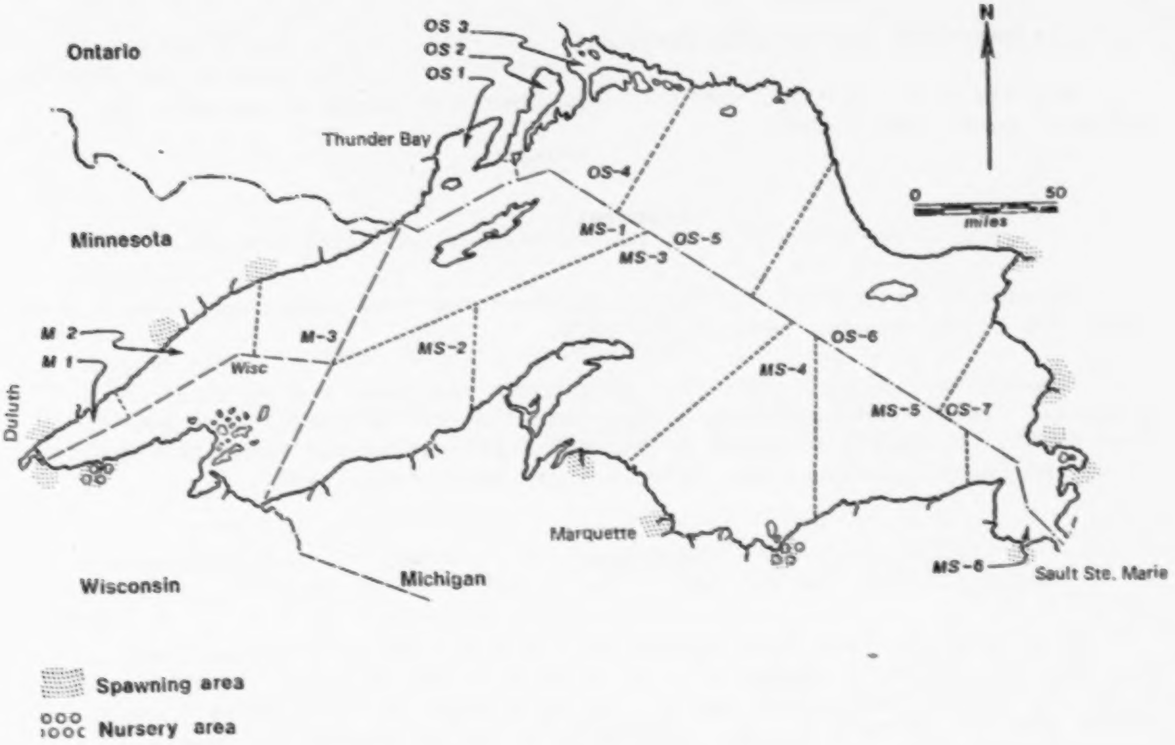
OS-6

Michipicoten River (47°56', 84°51').

OS-7

Agawa River (47°21', 84°38') and Speckled Trout Creek (47°19', 84°36').

CHINOOK SALMON


OS 3
OS 2
OS 1
Ontario
Thunder Bay
N
0
50
miles
Minnesota
OS-4
MS-1
OS-5
MS-3
M 2
M 1
M-3
MS-2
Wisc
OS-6
MS-4
Duluth
MS-5
OS-7
Marquette
MS-6
Sault Ste. Marie
Wisconsin
Michigan
Spawning area
Nursery area

Chinook salmon were first introduced into Lake Superior in 1873, however, self-sustaining populations were not established. Chinook salmon planted in Lake Superior in 1967 (Parsons 1973) produced spawning runs in a number of Lake Superior tributaries and self-sustaining populations are established in some areas.

Minnesota

Runs usually begin in late August to September and peak in mid-October, but no natural reproduction is expected (H. Johnson, pers. comm. 1979). Some returns from plantings have occurred in the following rivers (GLFC 1976; Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979).

M-1

French River (46°54', 91°53').

M-2

Cascade River (47°42', 90°31').

Baptism River (47°20', 91°12'). Runs begin as early as mid-July (H. Johnson, pers. comm. 1979).

Wisconsin

Nemadji River (46°42', 92°02'). Some returns from plantings (DeVore 1978; FWS 1979d; Schram, pers. comm. 1979).

Brule River (46°45', 91°37'). Runs enter the river and move into Blueberry Creek, where spawning occurs and young-of-the-year (YOY) have been found. The first evidence of natural reproduction was found in 1979 (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979).

Michigan

Chinook salmon have been planted in the Black (46°40', 90°03'), Big Iron (46°50', 89°34'), Sturgeon (47°02', 88°29'), Falls (46°45', 88°27'), Huron (46°55', 88°02'), Dead (46°34', 87°23'), Anna (46°25', 86°38') and Sucker (46°40', 85°56') rivers, and Cherry Creek, a tributary of the Chocolay River (46°30', 87°21') (GLFC 1973a,b, 1975, 1976, 1978; MDNR 1970; Parsons 1973; USDI 1970).

MS-3

Huron River (46°55', 88°02'). A few spawners returned in 1969 and 1970 (Parsons 1973).

MS-4

Dead River (46°34', 87°23'). Adults begin congregating near the mouth of the river in early fall. Two separate runs that did not overlap were observed entering the river. One run occurred in late August to late September, when water temperatures were 55-63°F, and the other run in late October to early November, when the water temperatures were 37-45°F. Runs also enter the discharge canal of the nearby Presque Isle Power Station. Suitable spawning grounds do not exist in the river, no redds have been seen, and no successful reproduction occurs (Berg 1976; FWS 1979d; Wapora 1976a,b).

Anna River (46°25', 86°38'). Successful reproduction occurs from plantings in 1969 (Berg 1976; Stauffer 1974b). Naturally spawned YOY were observed in 1973 and 1974 (Stauffer 1974b, 1975).

MS-6

Pendills Creek (46°27', 84°49'). A spawning run enters this creek (Gleason and Behmer, pers. comm. 1979).

Ontario

Runs enter the following streams during September-November.

OS-6

Magpie River (47°58', 84°52') (OMNR 1976b).

Michipicoten River (47°56', 84°51'). Small numbers were seen spawning here on October 1-2, 1975 (OMNR 1976b; Schleen 1975).

OS-7

Agawa River (47°21', 84°38'), Montreal River (47°15', 84°39'), Pancake River (46°58', 84°40'), and Stokely Creek (46°49', 84°25') (OMNR 1976b).

PYGMY WHITEFISH

Minnesota

Spawning occurs in the fall all along the shore over rock and rubble bottom (H. Johnson, pers. comm. 1979).

Michigan

MS-1

Isle Royale (48°00', 88°50'). Young-of-the-year were found in September and October in Siskiwit Bay at 47°55, 88°57' (Eschmeyer and Bailey 1955).

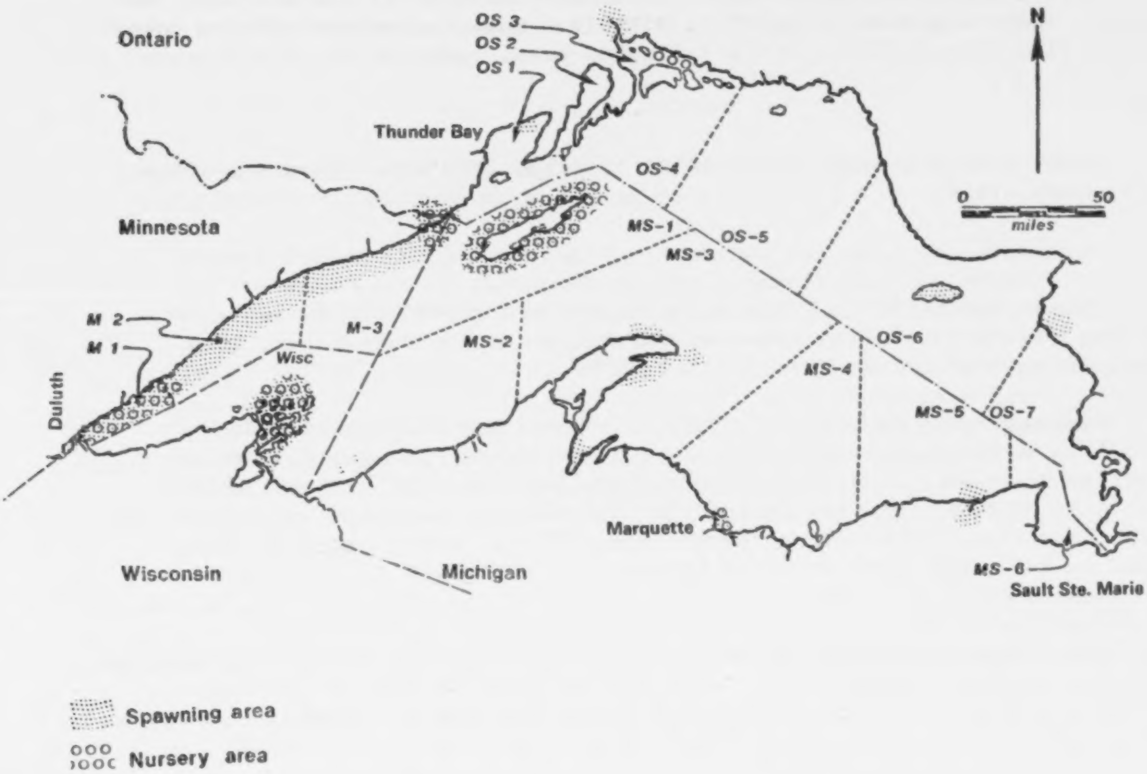
MS-3

Keweenaw Bay (46°58', 88°20'). Young-of-the-year were found off Point Abbaye (46°58', 88°08') in September and October (Eschmeyer and Bailey 1955).

MS-4

Laughing Fish Point (46°32', 87°01'). This species spawns during November and December, based on collections in 1953 at Laughing Fish Point; fish were not ripe in late October, but were spent in early January. The spawning grounds were not identified, but were assumed to be in relatively shallow water (78-108 ft deep), where young were found. Young-of-the-year were found off Laughing Fish Point in September and October (Eschmeyer and Bailey 1955).

ROUND WHITEFISH


Ontario
OS 3
OS 2
OS 1
N
Thunder Bay
OS-4
0
50
miles
Minnesota
MS-1
OS-5
MS-3
M 2
M 1
M-3
MS-2
OS-6
Wisc
MS-4
Duluth
MS-5
OS-7
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie
Spawning area
Nursery area

Minnesota

The round whitefish spawns from late November into January in Minnesota waters. Adults move inshore to shallow beach areas where they spawn over rock and gravel. Spawning occurs along the shore from the Pigeon River (48°00', 89°34') to Duluth (46°48', 92°05') (Croft, pers. comm. 1979; Fenstad, pers. comm. 1979; Hassinger, pers. comm. 1979; Hendrickson, pers. comm. 1979; W. Johnson, pers. comm. 1979; Koss and Koss, pers. comm. 1979; Spry, pers. comm. 1979; Sve, pers. comm. 1979; Zerbach, pers. comm. 1979). Adults also enter rivers in the fall and may spawn there (Lawrie 1978). Specific locations of spawning and nursery areas are:

M-1

Knife River (46°57', 91°47')--Duluth (46°48', 92°05'). This entire inshore area is a spawning and nursery area (Hassinger, pers. comm. 1979).

A commercial fisherman caught spawners in December from Stony Point (46°56', 91°49') to Talmadge River (46°53', 91°55') (W. Johnson, pers. comm. 1979).

Silver Creek (47°04', 91°36'). Spawning occurs off the mouth of the creek. Fisherman's Point (47°02', 91°38'). Spawning occurs off the point and in Flood Bay (47°02', 91°38') (Croft, pers. comm. 1979).

M-2

Split Rock Cabins (47°10', 91°25'). Ripe fish were taken here (Sve, pers. comm. 1979).

M-3

Pigeon Bay (48°01', 89°31') and Pigeon River (48°00', 89°34'). Both the bay and the river are spawning and nursery areas (Hassinger, pers. comm. 1979; Hendrickson, pers. comm. 1979).

Wauswaugoning Bay (47°58', 89°37')--Grand Portage Bay (47°57', 89°40'). Both bays are spawning and nursery areas (Hassinger, pers. comm. 1979; Hendrickson, pers. comm. 1979). The reef (47°57', 89°40') on the west side of Grand Portage Island (47°57', 89°40') is a very good location for taking ripe adults (Spry, pers. comm. 1979). Young have also been found on the north side of Susie Island (47°59', 89°34') (Hendrickson, pers. comm. 1979).

Grand Marais (47°45', 90°20'). Spawning occurs throughout the area in December (Zerbach, pers. comm. 1979). The mouths of the Devil Track (47°46', 90°16') and Cascade (47°42', 90°31') rivers are spawning areas (Koelz 1929).

Wisconsin

Round whitefish probably spawn on almost any rocky area less than 10 ft deep (Coberly and Horrall 1980b; Swanson, pers. comm. 1979). A few young-of-the-year (YOY) were collected in the Apostle Islands (47°00', 90°40') in late July 1953 (Eschmeyer and Bailey 1955).

Sand Cut Reef (46°44', 90°41'). A spawning area (Pycha, pers. comm. 1979).

York Island (46°59', 90°52'). Large numbers of spawning fish were observed off the east side of the island by fishermen. Raspberry Island (46°58', 90°48'). Large numbers of spawning fish were observed all around the island by fishermen. Outer Island (47°02', 90°26'). Large numbers of spawning fish were observed at the south end (46°59', 90°27') of the island by fishermen. Michigan Island (46°53', 90°29'). Large numbers of spawning fish were observed all along the east shore by fishermen (Coberly and Horrall 1980b).

Michigan

MS-1

Isle Royale (48°00', 88°50'). Round whitefish spawn in the bays around the island (Fenstad, pers. comm. 1979). Young were seined along shore (Hubbs and Lagler 1947).

MS-3

Keweenaw Peninsula (47°10', 88°30'). Spawning occurs in several areas during mid-November to mid-December (Organ et al. 1978).

> Copper Harbor (47°28', 87°54'). Spawning has occurred over rock at the west side of the mouth of the harbor since the 1930s. Manitou Island (47°25', 87°37'). Spawning has been observed all around the island on rocky shoals since the 1930s. Keweenaw Point (47°24', 87°43')--Point Isabelle (47°21, 87°56'). Spawning occurred over rock in an area extending from Keweenaw Point through Bete Grise Bay (47°23', 87°56') and around Point Isabelle in 1973. This includes an area (47°19', 87°58') west of Point Isabelle that has been used since the 1930s. Gay (47°14', 88°10'). Spawning has been observed in a rock area (47°15', 88°06') about 3 mi N of Gay since the 1930s.

Keweenaw Bay (46°58', 88°20'). Several small spawning areas have been reported in the bay. A rock area (46°52', 88°27') north of the community of Keweenaw Bay (46°52', 88°29') has been used since the 1940s. Areas used since 1963 are rock along the shore of Pequaming Point (46°51', 88°24'), rock along shore midway between Pequaming Bay (46°50', 88°24') and L'Anse Bay (46°46', 88°28'), sand in deeper water north of Sand Point (46°47', 88°28'), and sand in mid-bay (46°51', 88°26') west of Pequaming (Organ et al. 1978).

MS-4

Marquette (46°33', 87°23'). Round whitefish are believed to spawn on rock and gravel areas in Presque Isle Harbor (46°34', 87°23'), but this has not been confirmed (Wapora 1976a,b). Nearly ripe adults were found in the harbor during the fall (Wapora 1976b), and larvae believed to be of this species were found there in February-May (Wapora 1976b). Round whitefish eggs were found in stomachs of fish in the harbor in 1972 (FWS 1979d).

MS-5

Big Two Hearted River (46°42', 85°25'). A run enters the river in the fall (Stauffer and Hansen 1958), and spawning has occurred in October and November over sand at the river mouth since 1945 (Organ et al. 1978).

Little Lake Harbor (46°43', 85°22'). A run occurs in the fall (Stauffer and Hansen 1958), and spawning has taken place in October and November over sand at the harbor mouth since 1945 (Organ et al. 1978).

Ontario

OS-1

MacKenzie Bay (48°31', 88°57'). Small whitefish, 2-4 in. long, tentatively identified as round whitefish, were collected here; spawning probably occurred on the gravel shoals in the bay (SLCC 1979b).

OS-3

Nipigon River (48°57', 88°15'). Many round whitefish were caught in the lower river in mid-September and spawning is believed to occur there (Pycha, pers. comm. 1979).

Cypress River (48°56', 87°52')--Gravel River (48°55', 87°46'). Many YOY were collected in late July 1979 at the river mouths and were assumed to have hatched nearby (SLCC 1979b).

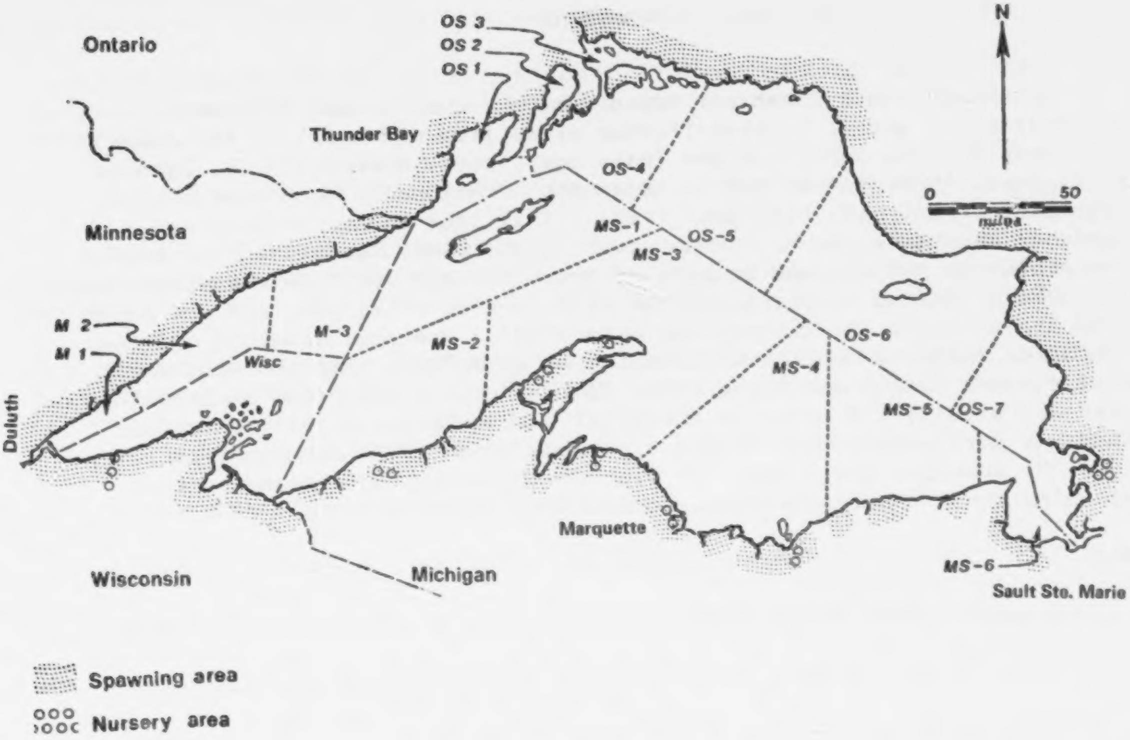
OS-6

Michipicoten Island (47°45', 85°47'). Fall runs entered creeks on the island and spawning probably occurred (Koelz 1929).

OS-7

Gargantua (47°35', 84°58'). Fall runs entered creeks near Gargantua and spawning probably occurred (Koelz 1929).

RAINBOW TROUT


Ontario
OS 3
OS 2
OS 1
Thunder Bay
N
0
50
miles
OS-4
MS-1
OS-5
MS-3
Minnesota
M 2
M 1
M-3
MS-2
Wisc
D
OS-6
MS-4
MS-5
OS-7
Duluth
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie
Spawning area
Nursery area

Rainbow trout were first introduced in Lake Superior in 1889 when the U.S. Fish Commission stocked the Iron River (46°49', 87°39') in Michigan (U.S. Comm. Fish Fish. 1889-91 as cited in MacCrimmon and Gots 1972) and Wisconsin planted fry in waters of Ashland County (Wis. Fish. Comm. 1889 as cited in MacCrimmon and Gots 1972). The first rainbow trout taken in the Great Lakes was captured on the north shore of Lake Superior in July 1895 (Smedley 1895).

In 1956, the rainbow trout (steelhead trout) was described as the most important game fish that ran into Lake Superior tributaries (Erkkila et al. 1956). Most U.S. tributaries have spawning runs (FWS 1979d). Spawning runs may occur in spring and fall; major runs usually occur in the spring (OMNR 1976b). Incidental catches of rainbow trout in the spring were reported for 114 U.S. streams (Moore and Braem 1965); these catches indicate spawning runs occur in these streams (Braem, pers. comm. 1980). Most Ontario tributaries support both spring and fall runs (OMNR, undated); 110 streams, some unnamed, have runs (OMNR 1976b).

Minnesota

Spawning runs and natural reproduction occur in most Minnesota tributaries on gravel in fast-flowing areas from mid-April to mid-June; runs peak in late April and May (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979; Surber 1920). Spawning occasionally continues into late July (Minn. Div. Fish Game 1963). Fall runs during October and November sometimes occur, but no spawning has been observed and no adults overwinter in the streams because of heavy ice and low flow (Hassinger et al. 1974). Stream discharge in the fall is also often low, and the fall runs are sporadic (MacCrimmon and Gots 1972). Upstream movement and the amount of spawning habitat are limited by waterfalls near the mouths of most streams (Smith and Moyle 1944; USDI 1970). Young spend at least one year and usually 2-4 years in the natal stream before migrating to Lake Superior during May-July (Hassinger, pers. comm. 1979; Hassinger et al. 1974; H. Johnson, pers. comm. 1979). The following 59 streams support spawning runs (Hassinger, pers. comm. 1979; Hassinger et al. 1974):

M-1

Chester Creek (46°48', 92°05') and Tischer Creek (46°49', 92°03').

Lester River (46°50', 92°00') (Minn. Div. Fish Game 1963).

Talmadge River (46°53', 91°55') and French River (46°54', 91°53') (Minn. Div. Fish Game 1963; Moore and Braem 1965).

Schmidt Creek (46°54', 91°53').

Big Sucker Creek (Sucker River) (46°55', 91°51') (Minn. Div. Fish Game 1963).

Knife River (46°57', 91°47') and Stewart River (47°03', 91°38') (Minn. Div. Fish Game 1963; Moore and Braem 1965).

Silver Creek (47°04', 91°36') (Minn. Div. Fish Game 1963).

M-2

Encampment River (47°05', 91°34'), Crow Creek (47°06', 91°33'), and Castle Creek (47°07', 91°30').

Gooseberry River (47°08', 91°27') (Minn. Div. Fish Game 1963).

Twin Points Creek (47°10', 91°25').

Split Rock River (47°11', 91°24') (Minn. Div. Fish Game 1963).

Unnamed tributary (47°11', 91°23').

Beaver River (47°15', 91°18'), Palisade Creek (47°19', 91°12'), and Baptism River (47°20', 91°12') (Minn. Div. Fish Game 1963).

Little Marais River (47°25', 91°06'), Dragon Creek (47°25', 91°06'), Manitou River (47°27', 91°04'), and Little Manitou River (47°27', 91°03').

Caribou River (47°28', 91°02') (Minn. Div. Fish Game 1963).

Sugar Loaf Creek (47°29', 90°59'), Last Creek (47°30', 90°58'), Unnamed tributary (47°30', 90°57'), and Two Island River (47°31', 90°55').

Cross River (47°32', 90°53'), Temperance River (47°33', 90°52'), and Onion River (47°37', 90°46') (Minn. Div. Fish Game 1963).

Rollins Creek (47°37', 90°45').

Poplar River (47°38', 90°42') (Minn. Div. Fish Game 1963).

Lutsen Creek (47°39', 90°40'), and Jonvick Creek (47°39', 90°39').

Spruce Creek (47°40', 90°38') (Minn. Div. Fish Game 1963).

Indian Camp Creek (47°41', 90°33').

M-3

Cascade River (47°42', 90°31') (Minn. Div. Fish Game 1963; Moore and Braem 1965).

Cutface Creek (47°44', 90°26').

Rosebush Creek (47°44', 90°21') (Minn. Div. Fish Game 1963).

Devil Track River (47°46', 90°16') (Minn. Div. Fish Game 1963; Moore and Braem 1965).

Durfee Creek (47°47', 90°14') (Minn. Div. Fish Game 1963).

Cliff Creek (47°47', 90°11').

Kimball Creek (47°47', 90°11') (Minn. Div. Fish Game 1963).

Stone Creek (47°48', 90°09').

Kadunce Creek (47°48', 90°09') (Minn. Div. Fish Game 1963; Moore and Braem 1965).

East Colville Creek (47°48', 90°06').

Brule (Arrowhead) River (47°49', 90°03') (Minn. Div. Fish Game 1963; Moore and Braem 1965).

Myhr's Creek (47°49', 90°02').

Flute Reed River (47°50', 89°58') and Carlson Creek (47°51', 89°56') (Minn. Div. Fish Game 1963).

Farquhar Creek (47°52', 89°55').

Reservation River (47°52', 89°51') (Minn. Div. Fish Game 1963).

Unnamed Tributary (47°54', 89°46'), Hollow Rock Creek (47°55', 89°44'), Unnamed Tributary (47°56', 89°43'), Grand Portage River (47°58', 89°41'), and Pigeon River (48°00', 89°34').

Wisconsin

Large runs occur in tributaries during early spring (Calhoun and Coon 1941). Runs enter small rivers in April and May; in larger tributaries, runs may occur in late March under the ice. Some rivers have two runs, one in late winter-early spring, and another in late April-early May (King and Swanson, pers. comm. 1979). Rainbow trout also run in the fall and overwinter in the Brule River (46°45', 91°37') (Hassinger et al. 1974; Niemuth 1970; Schram, pers. comm. 1979). Runs occur in the following tributaries:

Nemadji River (46°42', 92°02') (DeVore 1978, pers. comm. 1979; DeVore et al. 1978; FWS 1979d; Moore and Braem 1965).

Amnicon River (46°41', 91°51') (Moore and Braem 1965; Schram, pers. comm. 1979).

Middle River (46°42', 91°50') and Poplar River (46°42', 91°47') (Moore and Braem 1965).

Brule River (46°45', 91°37') (GLFC 1961, 1967; King and Swanson, pers. comm. 1979; Moore and Braem 1965; Niemuth 1970; Pycha, pers. comm. 1979; Salli 1974; Schram, pers. comm. 1979). Stocking has occurred since the 1890s; spring runs have occurred since the 1920s and fall runs since at least the 1940s (Niemuth 1970). The principal run occurs in the fall (Niemuth 1970; O'Donnell and Churchill 1954). Young spend their first few years in the river before migrating to the lake (Salli 1974).

Iron River (46°46', 91°29'), Flag River (46°47', 91°23'), and Cranberry River (46°50', 91°16') (King and Swanson, pers. comm. 1979; Moore and Braem 1965).

Bark River (46°51', 91°11') (King and Swanson, pers. comm. 1979).

Siskiwit River (46°51', 91°06') (King and Swanson, pers. comm. 1979; Moore and Braem 1965; Schram, pers. comm. 1979).

Sand River (46°56', 90°56') (King and Swanson, pers. comm. 1979; Moore and Braem 1965).

Raspberry River (46°56', 90°50') (King and Swanson, pers. comm. 1979; Pycha, pers. comm. 1979).

Brickyard Creek (46°50', 90°48') (Moore and Braem 1965).

Pike's Creek (46°47', 90°51') (King and Swanson, pers. comm. 1979; Moore and Braem 1965; Pycha, pers. comm. 1979).

Onion River (46°45', 90°53') (Moore and Braem 1965).

Sioux and Little Sioux Rivers (46°44', 90°52') (King and Swanson, pers. comm. 1979; Moore and Braem 1965; Pycha, pers. comm. 1979).

Thompson Creek (46°40', 90°55') and Bono Creek (46°38', 90°55') (King and Swanson, pers. comm. 1979).

Whittlesey Creek (46°36', 90°57') (King and Swanson, pers. comm. 1979; Moore and Braem 1965).

Fish Creek (46°35', 90°57') (King and Swanson, pers. comm. 1979; Moore and Braem 1965; Pycha, pers. comm. 1979).

Bad and White Rivers (46°38', 90°39') (King and Swanson, pers. comm. 1979; Moore and Braem 1965; Sather and Threinen 1966).

Bell Creek (46°35', 90°33'), Graveyard Creek (46°35', 90°29'), Oronto Creek (46°34', 90°26'), Parker Creek (46°34', 90°26'), and Montreal River (46°34', 90°25') (Andrews and Threinen 1969; Moore and Braem 1965).

Michigan

Spawning runs occur in the following tributaries:

MS-1

Isle Royale (48°00', 88°50'). Runs occur in Washington (47°55', 89°09') and Grace (47°53', 89°12') creeks (Moore and Braem 1965).

MS-2

Little Speckled Creek (46°36', 90°17') and Maple Creek (46°39', 90°07') (Moore and Braem 1965).

Black River (46°40', 90°03') (Ann Arbor News 1979a).

Presque Isle River (46°43', 89°58'). Spring and fall runs (Hansen and Stauffer 1967).

Carp River (46°46', 89°53') (Moore and Braem 1965).

Union River (46°49', 89°37'). Runs occur, and young-of-the-year (YOY) have been collected (Jenkins 1970; Moore and Braem 1965; Peck and Stauffer 1968; Stauffer 1969a,b, 1971c,d, 1973a, 1974a, 1975b, 1977, 1979a).

Little Iron River (46°50', 89°35') and Cranberry River (46°50', 89°25') (Moore and Braem 1965).

Ontonagon River (46°52', 89°20') (Moore and Braem 1965; Wagner 1961).

Flint Steel River (46°56', 89°12') (Moore and Braem 1965).

Fire Steel River (46°56', 89°12') (GLFC 1967; Moore and Braem 1965).

Misery River (47°00', 88°59') (GLFC 1967; Moore and Braem 1965; Stauffer and Hansen 1958).

Little Elm River (47°02', 88°56') (Moore and Braem 1965).

MS-3

Elm River (47°03', 88°55'), Graveraet River (47°07', 88°51'), Schlot (Schlotz) Creek (47°11', 88°39'), Coles Creek (47°08', 88°37'), Lake Annie Outlet (47°11', 88°37'), Boston-Lily Creek (48°11', 88°38'), Smith Creek (47°15', 88°34'), and McGunn's Creek (47°15', 88°33') (Moore and Braem 1965).

Gratiot River (47°21', 88°27'). Runs occur, and YOY were present at the river mouth (Moore and Braem 1965; Shetter 1950).

Garden City Brook (47°25', 88°18') and Trap River (Eliza Creek) (47°28', 88°10') (Moore and Braem 1965).

Silver River (47°28', 88°04'). Runs occur, and YOY were present at the river mouth (Moore and Braem 1965; Shetter 1950).

Fanny Hooe Creek (47°28', 87°52') (North Woods Call 1979k).

Bear Creek (47°24', 87°55'), Little Gratiot River (47°22', 88°02'), Tobacco River (47°14', 88°09'), Traverse River (47°11', 88°14'), Mud Lake Outlet (47°08', 88°17'), Sturgeon River (47°02', 88°29'), Pike River 47°01', 88°32'), Pilgrim River (47°06', 88°31'), Trap Rock River (47°11', 88°24'), Kelsey Creek (46°53', 88°28'), Little Carp River (46°50', 88°29'), Falls River (46°45', 88°27'), Meadow Brook (46°46', 88°27'), Little Silver Creek (46°49', 88°25') (Moore and Braem 1965).

Silver River (46°49', 88°17') (GLFC 1967; Moore and Braem 1965; Shetter 1950; Stauffer and Hansen 1958).

Slate River (46°50', 88°16'), Ravine River (46°50', 88°15'), and Gulskog Creek (46°55', 88°08') (Moore and Braem 1965).

Huron River (46°55', 88°02'). Supports heavy runs into Chinks Creek, a tributary; spawning fish, and YOY have been collected in the river (GLFC 1967, 1968b; Jenkins 1970; Miller and Scott 1968; Moore and Braem 1965; Peck and Stauffer 1968; Stauffer 1969a,b, 1971b,c,d, 1973a, 1974a, 1975a,b, 1977, 1979a; Stauffer and Hansen 1958; Wagner and Stauffer 1978).

Little Huron River (46°54', 88°00'). Spawning runs enter the river, and YOY have been collected (Jenkins 1970; Moore and Braem 1965; Stauffer 1969a,b, 1971c,d, 1973a, 1974a, 1975b, 1977, 1979a).

Pine River (46°53', 87°52') and Salmon Trout River (46°52', 87°46'). (Moore and Braem 1965).

MS-4

Little Iron River (46°49', 87°39') (Moore and Braem 1965).

Big Garlic River (46°43', 87°34') (Moore and Braem 1965; Stauffer 1971b).

Little Garlic River (46°41', 87°31'). Spawning runs enter the river, and YOY have been collected (Hannuksela 1978; Jenkins 1970; Moore and Braem 1965; Peck and Stauffer 1968; Stauffer 1969a,b, 1971b,c,d, 1974a, 1975a,b, 1977, 1979a).

Harlow Creek (46°38', 87°28') (Moore and Braem 1965).

Dead River-Presque Isle Harbor (46°34', 87°23'). A spring run enters the harbor in April-June and peaks in late April or early May. Adults have not been seen in the river during the spring run, but adults ascend the discharge canal of the Presque Isle Power Station. No evidence of spawning has been found in the harbor. A small run also occurs in October and November and fish ascend both the river and the discharge canal. There is little potential for successful spawning in either the harbor or the river (Berg 1976; Moore and Braem 1965; Wapora 1976b).

Shiras Hill Creek (46°33', 87°23'), Deertrack Creek (46°32', 87°23'), and Carp River (46°31', 87°23') (Moore and Braem 1965).

Chocolay River (46°30', 87°21') (Moore and Braem 1965; Stauffer and Hansen 1958).

Sand River (46°30', 87°06'), Laughing Whitefish River (46°31', 87°02'), and Deer Lake Creek (46°28', 86°57') (Moore and Braem 1965).

Rock River (46°28', 86°55') (Moore and Braem 1965; Stauffer and Hansen 1958).

Au Train River (46°26', 86°51') and Five Mile Creek (46°28', 86°44') (Moore and Braem 1965).

Furnace Creek (46°26', 86°42') (GLFC 1967; Moore and Braem 1965).

Anna River (46°25', 86°38'). Spawning runs enter the river, and YOY have been collected (Jenkins 1970; Moore and Braem 1965; Peck and Stauffer 1968; Stauffer 1969a,b, 1971c,d, 1973a, 1974a, 1975b, 1977, 1979a).

Tannery Falls Creek (46°26', 86°37') and Munising Falls Creek (46°27', 86°36') (Moore and Braem 1965).

Miners Creek (46°30', 86°33') (GLFC 1967; Moore and Braem 1965; Stauffer and Hansen 1958).

Mosquito River (46°32', 86°30') (Moore and Braem 1965; Stauffer and Hansen 1958).

MS-5

Beaver Lake Creek (46°35', 86°21') (Moore and Braem 1965).

Seven Mile Creek (46°37', 86°16'). Runs occur, and YOY have been found (Moore and Braem 1965; Peck and Stauffer 1968).

Sullivan Creek (46°39', 86°11') and Hurricane River (46°40', 86°10') (Moore and Braem 1965).

Sable Creek (46°40', 86°01') (Moore and Braem 1965; Swedberg, pers. comm. 1979).

Sucker River (46°40', 85°56') (GLFC 1967; Moore and Braem 1965; Pycha, pers. comm. 1979; Stauffer and Hansen 1958).

Blind Sucker River (46°41', 85°40') (Moore and Braem 1965).

Big Two Hearted River (46°42', 85°25') (GLFC 1967; Hansen and Stauffer 1967; Moore and Braem 1965; Stauffer and Hansen 1958).

Little Two Hearted River (46°43', 85°22') and Three Mile Creek (46°44', 85°19') (Moore and Braem 1965).

MS-6

Betsy River (46°41', 85°01'), Tahquamenon River (46°33', 85°02'), Roxbury Creek (46°29', 85°01'), Ankodosh Creek (46°29', 85°00'), Naomikong Creek (46°29', 84°58'), Mill Creek (46°29', 85°57'), Halfaday Creek (46°28', 84°54'), and Grants Creek (46°28', 84°52') (Moore and Braem 1965).

Pendills Creek (46°27', 84°49') (Gleason and Behmer, pers. comm. 1979; Moore and Braem 1965).

Ontario

Of the 110 known spawning streams, 30 support major runs (over 200 fish) (OMNR 1976b).

OS-1

Pigeon River (48°00', 89°34'), Little Pine River (48°02', 89°31'), and Pine River (48°03', 89°30'). Cloud River (48°05', 89°26'), Jarvis River (48°07', 89°21'), and Lomond River (48°16', 89°16'). Major runs. Whiskeyjack Creek (48°21', 89°13'). Kaministiquia River (48°23', 89°13'), Neebing River (48°24', 89°13'), and McIntyre River (48°25', 89°13). Major runs. McVicar Creek (48°26', 89°13'), Current River (48°27', 89°11'), Wildgoose Creek (48°29', 89°04'), and Blind River (48°30', 89°01'). MacKenzie River (48°32', 88°57'). Major runs. Blende River (48°34', 88°46').

OS-2

Joeboy River (48°29', 88°42'). Portage Creek (48°33', 88°38'). Major run. D'Arcy Creek (48°37', 88°37'). Pearl River (48°37', 88°37'). Major run. Welch Creek (48°39', 88°33'). Coldwater Creek (48°48', 88°31') and Wolf River (48°49', 88°29'). Major runs. Little Squaw Creek (48°51', 88°27') and Black Sturgeon River (48°50', 88°24').

OS-3

Trout Creek (Big and Little) (48°57', 88°15'). Major run. Stillwater Creek (48°59', 88°16') and Cash Creek (49°06', 88°15'). Nipigon River (48°57', 88°15'). Major run. Firehill Creek (49°00', 88°06'), Jackfish River (49°00', 88°05'), and Ozone Creek (49°01', 88°02'). Jackpine River (48°58', 88°00') and Dublin Creek (48°57', 87°58'). Major runs. MacInnis Creek (48°56', 87°55'). Cypress River (48°56', 87°52'). Major run. Little Cypress River (48°56', 87°51'). Little Gravel River (48°55', 87°46') and Gravel River (48°55', 87°46'). Major runs. Pays Plat River (48°53', 87°34'), McKellar Creek (48°50', 87°28'), Hewitson River (48°50', 87°27'), Unnamed Tributary (48°51', 87°54'), Unnamed Tributary (48°47', 88°04'), and Unnamed Tributary (48°45', 88°06').

OS-4

Dawson Creek (48°37', 88°13'), Unnamed Tributary (48°38', 88°10'), Brook River (48°45', 87°58'), Tedesco Creek (48°46', 87°54'), and Unnamed Tributary (48°48', 87°48').

OS-5

Schreiber Creek (48°46', 87°15'), Aquasabon River (48°46', 87°07'), Steel River (48°46', 86°54'), Prairie River (48°47', 86°47'), Ripple Creek (48°47', 86°45'), and Dead Horse Creek (48°48', 86°41'). Little Pic River

(48°47', 86°38'). Major run. Mink Creek (48°46', 86°30') and Angler Creek (48°45', 86°25'). Pic River (48°36', 86°18'). Major run. White River (48°33', 86°16').

OS-6

White Gravel River (48°18', 86°10'), Swallow River (48°10', 86°05'), Holly Creek (48°05', 86°00'), and Imogen River (48°02', 85°55'). Pukaskwa (Puckasaw) River (48°00', 85°53'). Major run. Pipe River (47°56', 85°41'). University River (47°58', 85°12') and Dore' River (47°58', 84°57'). Major runs. Magpie River (47°58', 84°52').

Michipicoten River (47°56', 84°51'). Major run (OMNR 1976b). Contains the largest spawning ground (47°55', 84°48') in the area for Lake Superior rainbow trout (Environ. Can 1977c).

Old Woman River (47°47', 84°54') and Red Rock River (47°41', 84°59').

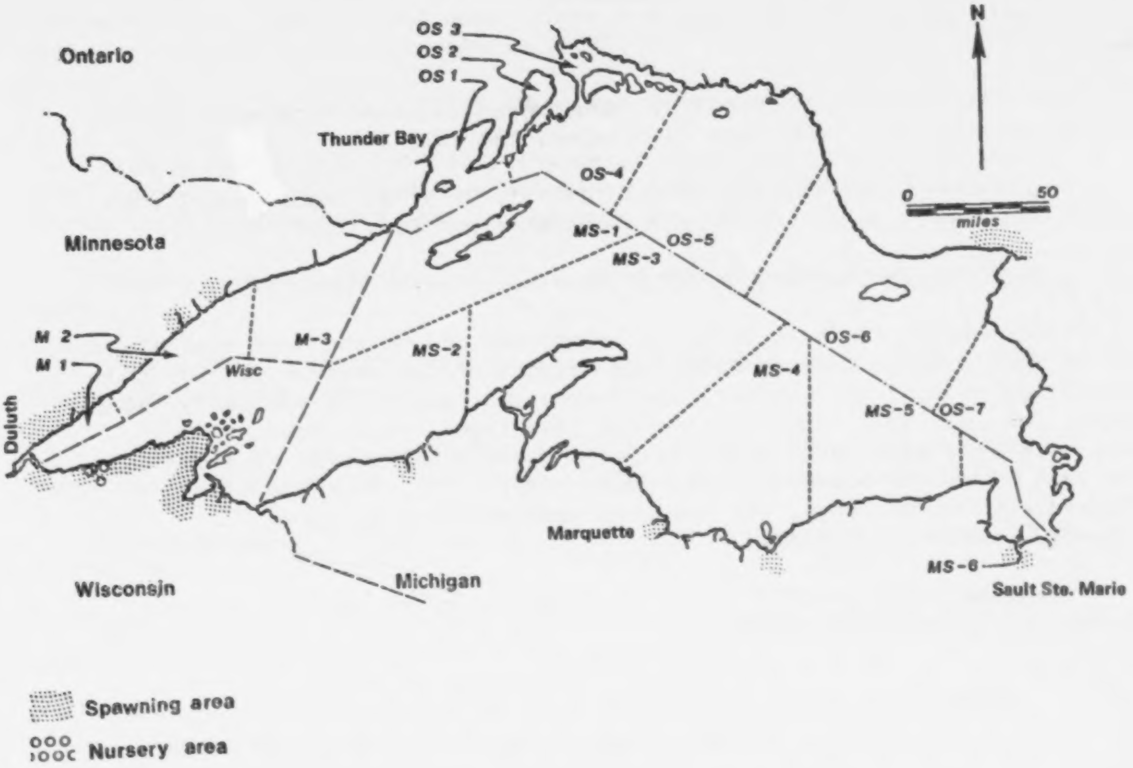
OS-7

Gargantua River (47°35', 85°00'), Buckshot Creek (47°31', 84°54'), Baldhead (Gravel) River (47°29', 84°50'), Coldwater River (47°28', 84°47'), Sand River (47°26', 84°44'), and Barrett River (47°24', 84°42'). Agawa River (47°21', 84°38'). Major run. Frater Creek (47°20', 84°37'), Speckled Trout Creek (47°19', 84°36'), and Laughing Brook (47°18', 84°35'). Montreal River (47°15', 84°39'). Major run. Unnamed Tributary (47°13', 84°40'), Metheany Creek (47°12', 84°41'), Alona Bay Creek (47°10', 84°42'), Dobson's Creek (47°09', 84°43'), Mica Bay Creek (47°07', 84°43'), Mamainse Creek (47°03', 84°46'), Breckenridge Creek (46°58', 84°46'), Unnamed Tributary (46°58', 84°45'), and Black Creek (46°58', 84°42'). Pancake River (46°58', 84°40'), Sable (Carp) River (46°57', 84°35'), and Batchawana River (46°56', 84°32'). Major runs. Chippewa River (46°56', 84°27'), Downey Creek (46°54', 84°23'), Jones Creek (46°53', 84°22'), Sawmill Creek (46°53', 84°22'), Government Creek (46°52', 84°22'), and Harmony River (46°51', 84°23').

Stokely Creek (46°49', 84°25'). Major run (OMNR 1976b). A run of ripe fish was present in the creek May 21-June 18, and peak abundance occurred on June 1 (Lawrie 1954, 1955). In 1970, adults returned to the lake immediately after spawning (Kwain 1971). Fingerlings were also found in the creek (Lawrie 1954).

Havilland Creek (46°49', 84°25'), Little Goulais River (46°46', 84°29'), Goulais River (46°43', 84°27'), Cranberry Creek (46°42', 84°25'), Unnamed Tributary (46°41', 84°26'), Unnamed Tributary (46°37', 84°32'), and Prince Creek (46°35', 84°35').

BROWN TROUT


Ontario
OS 3
OS 2
OS 1
Thunder Bay
N
0
50
miles
OS-4
MS-1
OS-5
MS-3
Minnesota
M 2
M 1
M-3
Wisc
MS-2
D
Duluth
MS-4
OS-6
MS-5
OS-7
Marquette
MS-6
Sault Ste. Marie
Wisconsin
Michigan
Spawning area
Nursery area

Brown trout were introduced into the Great Lakes as early as 1883. Brown trout in Lake Superior may have originated from eggs hatched at the Bayfield Fish Hatchery at Bayfield (46°49', 90°49'), Wisconsin, in 1887 (Brynildson et al. 1963).

Most lake-run populations of brown trout occur in the western end of the lake (Moore and Braem 1965). Runs enter tributaries in fall, and spawning usually occurs in October-early December (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979; Surber 1920). If upstream migration is blocked, spawning occurs on sand and gravel bars at stream mouths (Eddy and Underhill 1974) and along rocky shorelines in the lake proper (CDM/Limnetics 1976c). Young brown trout remain in the streams for 1-2 years and then move downstream to the lake (Hassinger, pers. comm. 1979;

Lawrie 1978; Salli 1974). Runs have been reported for the following U.S. tributaries:

Minnesota

M-1

Knife River (46°57', 91°47'). Eggs were collected from wild stock during October 1937, 1939, and 1940 (Minn. DNR 1937-59).

Big Sucker Creek (Sucker River) (46°55', 91°51'). Substantial runs occur (Hassinger, pers. comm. 1979; Schumaker and Eddy 1960).

Schmidt Creek (46°54', 91°53') (Hassinger, pers. comm. 1979).

French River (46°54', 91°53'). Supported one of the best runs along the Minnesota shore (Surber 1920) and was one of the major sites for the collection of eggs for hatchery use during the late 1930s and early 1940s (Minn. DNR 1937-59). Runs still occur (Hassinger, pers. comm. 1979). Runs were very good until about 10 years ago and moderately good through the late 1970s (H. Johnson, pers. comm. 1979). The river has been stocked with fingerlings, but few fish have returned to spawn (H. Johnson, pers. comm. 1979).

Talmadge River (46°53', 91°55') and Lester River (46°50', 92°00') (Hassinger, pers. comm. 1979).

M-2

Cross River (47°32', 90°53'). Substantial run (Schumaker and Eddy 1960).

Baptism River (47°20', 91°12'). The river was stocked with fingerlings, but few fish returned to spawn (H. Johnson, pers. comm. 1979).

Split Rock River (47°11', 91°24'). Eggs were taken from wild stock in this river during October 1939 (Minn. DNR 1937-59). Considerable natural reproduction was still occurring below the falls in the early 1940s (Smith and Moyle 1944). Fingerlings were stocked recently, but few fish have returned to spawn (H. Johnson, pers. comm. 1979).

Gooseberry River (47°08', 91°27'). Eggs were collected from wild stock during October 1939 (Minn. DNR 1937-59).

Wisconsin

Nemadji River (46°42', 92°02'). Runs move through the Duluth-Superior Harbor, enter the river, and ascend to the headwaters (DeVore 1978, pers. comm. 1979; FWS 1979d).

Brule River (46°45', 91°37'). Runs enter the river as early as July, and peak in August; spawning occurs in October (GLFC 1958, 1961; King and Swanson, pers. comm. 1979; Niemuth 1970; Salli 1974; Schram, pers. comm. 1979). Adults reportedly move east after spawning into bay areas along the south shore and into the Apostle Islands (47°00', 90°40') area (Niemuth 1970). Young spend their first few years of life in the river before migrating to the lake (Salli 1974).

Iron River (46°46', 91°29') (King and Swanson, pers. comm. 1979).

Flag River (46°47', 91°23'), Cranberry River (46°50', 91°16'), Bark River (46°51', 91°11'), and Siskiwit River (46°51', 91°06') (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979).

Raspberry River (46°56', 90°50') (King and Swanson, pers. comm. 1979).

Pike's Creek (46°47', 90°51') (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979).

Sioux and Little Sioux Rivers (46°44', 90°52') (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979; Pycha, pers. comm. 1979).

Thompson Creek (46°40', 90°55') (King and Swanson, pers. comm. 1979; Schram, pers. comm. 1979).

Bono Creek (46°38', 90°55') and Whittlesey Creek (46°36', 90°57') (King and Swanson, pers. comm. 1979).

Fish Creek (46°35', 90°57') (King and Swanson, pers. comm. 1979; Pycha, pers. comm. 1979; Schram, pers. comm. 1979).

Bad and White Rivers (46°38', 90°39') (King and Swanson, pers. comm. 1979).

Michigan

MS-2

Ontonagon River (46°52', 89°20') (Wagner 1961).

MS-4

Dead River (46°34', 87°23')--Presque Isle Harbor (46°34', 87°23'). Brown trout are present throughout the year in the harbor, and spawning occurs in the river or in rocky areas of the harbor during early November at about 47°F (Berg 1976; Wapora 1976a,b). In 1975, gravid females were found in the harbor in mid to late October and in the river in November. Spent females were subsequently found in the harbor in December (Wapora 1976b). Successful reproduction probably does not occur in the Dead River (Berg 1976, FWS 1979d).

Anna River (46°25', 86°38'). Spawning occurred in early November 1970 (Stauffer 1971a).

MS-6

Pendills Creek (46°27', 84°49') (Gleason and Behmer, pers. comm. 1979).

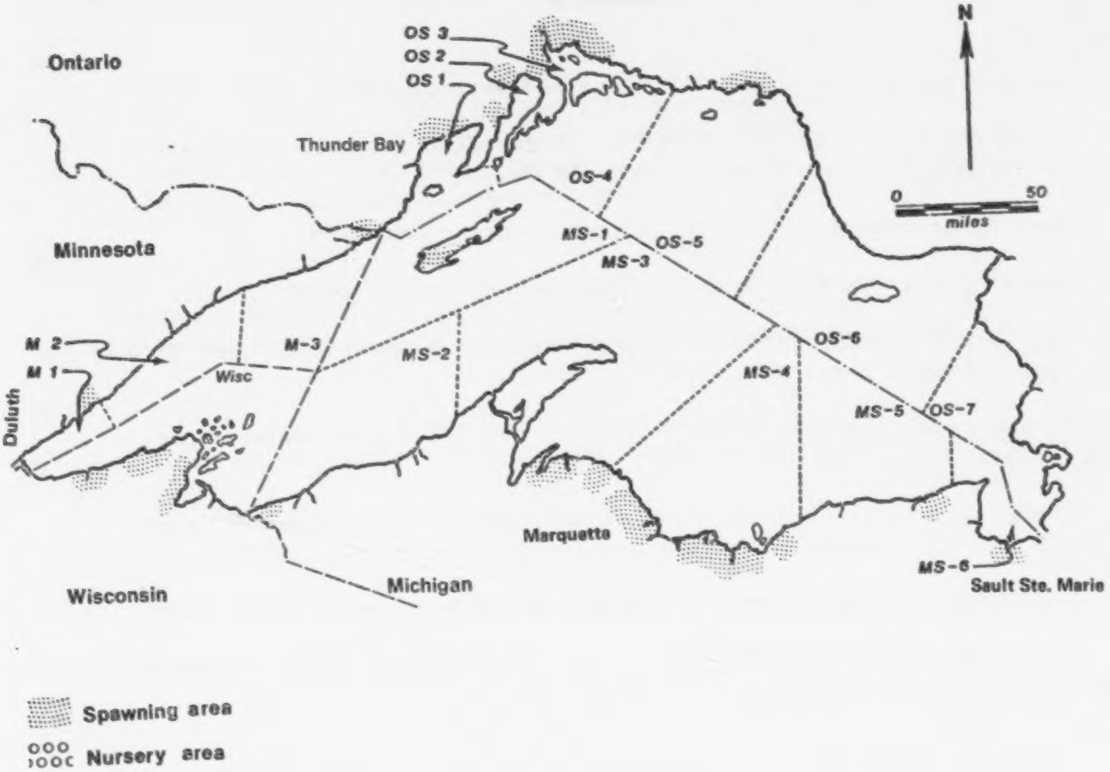
Ontario

Two Ontario tributaries in the eastern end of the lake support spawning runs in October and November (OMNR 1976b).

OS-6

Dore' River (47°58', 84°57'). Major run. Magpie River (47°58', 84°52'). Minor run.

BROOK TROUT


OS 3
OS 2
OS 1
Ontario
Thunder Bay
OS-4
MS-1
OS-5
MS-3
Minnesota
N
0
50
miles
M 2
M 1
M-3
Wisc
MS-2
Duluth
D
OS-6
MS-4
MS-5
OS-7
Marquette
MS-6
Sault Ste. Marie
Wisconsin
Michigan
Spawning area
Nursery area

In Lake Superior, lake-run populations of brook trout, called "coasters," ascend streams in the fall to spawn (Brash et al. 1962; Hassinger, pers. comm. 1979; Lawrie 1978; OMNR 1976b). Runs begin in mid August-early September and last until late November-early December (Eddy and Underhill 1974; Speirs 1955; Surber 1920). Spawning occurs at 40-49°F (Eddy and Underhill 1974). The streams in the region serve as nursery areas (Hassinger, pers. comm. 1979; King and Swanson, pers. comm. 1979). Fry are free-swimming in early March (Hale and Hilden 1969). Runs have been reported for the following U.S. tributaries:

Minnesota

M-1

Stewart River (47°03', 91°38'). Redds were seen in mid-October (Hale and Hilden 1969).

M-3

Pigeon River (48°00', 89°34') (Hassinger, pers. comm. 1979).

Wisconsin

Brule River (46°45', 91°37') (King and Swanson, pers. comm. 1979).

Cranberry River (46°50', 91°16'). A few fish run this river in October (King and Swanson, pers. comm. 1979).

Bark River (46°51', 91°11') (Schram, pers. comm. 1979).

Saxine Creek (46°53', 91'03') (Swanson and Pratt, pers. comm. 1979).

Oak Island Streams (46°56', 90°44') and Birch Run (46°47', 90°51') (King and Swanson, pers. comm. 1979).

Pike's Creek (46°47', 90°51'). Light run (King and Swanson, pers. comm. 1979).

Sioux and Little Sioux Rivers (46°44', 90°52') and Thompson Creek (46°40', 90°55'). Heavy run (King and Swanson, pers. comm. 1979).

Bono Creek (46°38', 90°55') (Swanson and Pratt, pers. comm. 1979).

Whittlesey Creek (46°36', 90°57') and Fish Creek (46°35', 90°57'). Light run (King and Swanson, pers. comm. 1979).

Michigan

MS-1

Isle Royale (48°00', 88°50'). This area supports the only remaining large, self-sustaining populations of coasters in Michigan waters of Lake Superior. Coasters move into Siskiwit Bay (47°57', 88°50'), and Tobin Harbor (48°09', 88°30'), and spawning occurs in the Big (47°54', 89°00') and Little (47°56', 88°57') Siskiwit rivers and Washington Creek (47°55', 89°09') (North Woods Call 1980c).

MS-2

Omans Creek (46°36', 90°20'). Historical run (Stauffer 1976b).

MS-3

Silver River (46°49', 88°17'). Lake-run fish are present in this river in fall (Stauffer and Hansen 1958).

Huron River (46°55', 88°02'). Historical run (Stauffer 1976b).

Salmon Trout River (46°52', 87°46'). Eggs were collected from coasters taken in the bay in late September (Stauffer 1967b). This is believed to be the last tributary on the Michigan mainland that supports native coasters (North Woods Call 1980c).

MS-4

Big Garlic River (46°43', 87°34'), Campau Creek (46°35', 87°25'), Sand River (46°30', 87°06'), Rock River (46°28', 86°55'), Au Train River (46°26', 86°51'), Furnace Creek (46°26', 86°42'), and Mosquito River (46°32', 86°30'). Historical runs occurred here (Stauffer 1976b).

MS-5

Big Two Hearted River (46°42', 85°25') and Little Two Hearted River (46°43', 85°22'). Historical runs occurred here (Stauffer 1976b).

MS-6

Halfaday Creek (46°28', 84°54') and Pendills Creek (46°27', 84°49') (Stauffer 1976b).

Ontario

Runs are reported in the following streams (OMNR 1976b):

OS-1

Current River (48°27', 89°11'), Blind River (48°30', 89°01'), and MacKenzie River (48°32', 88°57').

OS-2

Pearl River (48°37', 88°37'), Coldwater Creek (48°48', 88°31'), and Black Sturgeon River (48°50', 88°24').

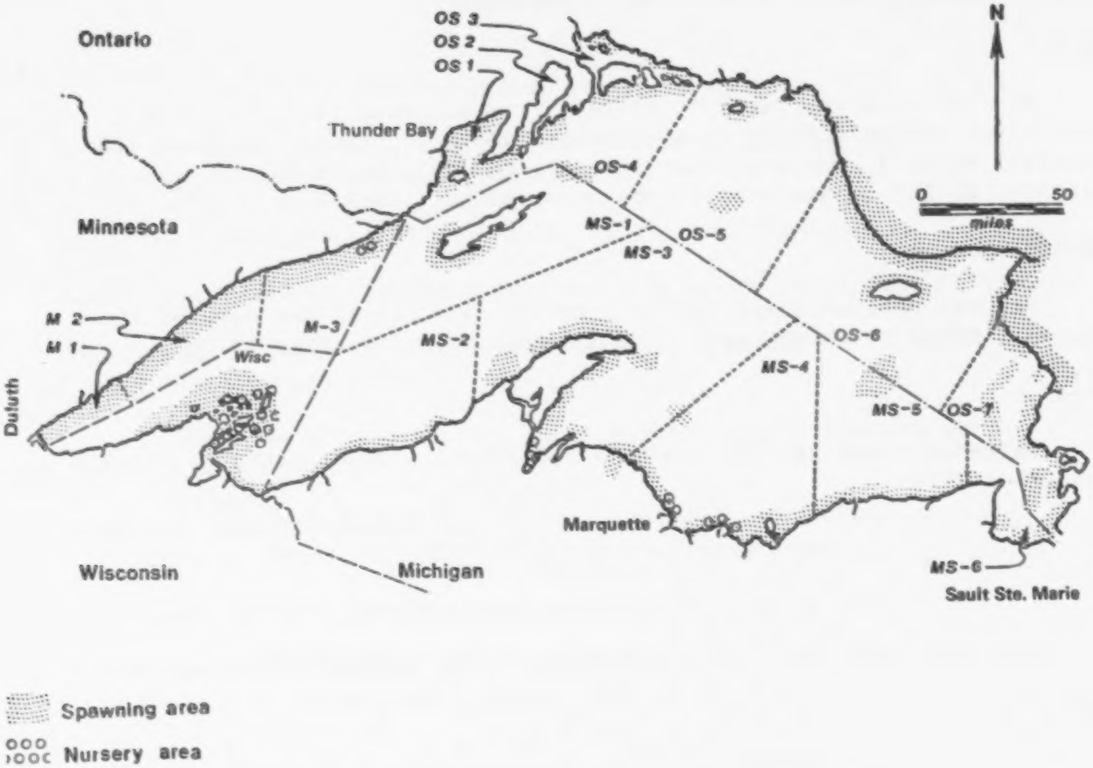
OS-3

Stillwater Creek (48°59', 88°16'), Nipigon River (48°57', 88°15'), Firehill Creek (49°00', 88°06'), Ozone Creek (49°01', 88°02'), Jackpine River (48°58', 88°00'), MacInnes Creek (48°56', 87°55'), Cypress River (48°56', 87°52'), and Little Gravel River (48°55', 87°46').

OS-5

Steel River (48°46', 86°54'), Prairie River (48°47', 86°47'), and Little Pic River (48°47', 86°38').

LAKE TROUT


OS 3
OS 2
OS 1
Ontario
Thunder Bay
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OS-4
0
50
miles
Minnesota
MS-1
OS-5
MS-3
M 2
M 1
M-3
MS-2
Wisc
OS-6
MS-4
MS-5
OS-7
Duluth
Marquette
Wisconsin
Michigan
MS-6
Sault Ste. Marie
Spawning area
Nursery area

The many races and subpopulations of lake trout in Lake Superior are reproductively isolated by spawning time and spawning location (Eschmeyer 1957; Lawrie and Rahrer 1973; Pycha and King 1975). Peak spawning usually occurs from late September to early November, but the spawning season can extend from June to late November, with the "siscowet" spawning much earlier than other races (Budd 1955; Calhoun and Coon 1941; Cook 1929; Eschmeyer 1955, 1957, 1964; Eschmeyer et al. 1952; Goode 1884; Koelz 1926; Lagler 1948; Leach 1923; Milner 1874a; Peck 1975a; Pycha and King 1975; Rathbun and Wakeham 1897; Scott 1936; Slastenenko 1958; Stauffer 1974c; U.S. Fish Comm. 1900). Spawning occurs on rocky reefs throughout the lake in 6-480 ft of water, depending on the variety of trout (Atlantic Fisherman 1948; Dymond 1928; Eschmeyer 1955, 1957, 1964; Goode 1884; Lawrie and Rahrer 1973; Leach 1923; Pycha and King 1975; Smith 1937). Some lake trout populations also run into tributaries to spawn (Eschmeyer 1957, 1964; Lawrie and Rahrer 1973; Loftus 1958; Smith 1969). Lake trout home to established spawning grounds; some planted trout also home to stocking sites, which are often unsuitable for successful reproduction (Eschmeyer 1955, 1957; Eschmeyer et al. 1952; Harris and Eschmeyer 1975; King and Swanson 1975; Lawrie and Rahrer 1973; Pycha and Dryer 1965; Pycha and King 1975; Pycha and Selgeby 1975). The adults remain on the spawning grounds for several weeks and then disperse to deeper water (Eschmeyer 1955; Eschmeyer et al. 1952; Scott 1936). Young-of-the-year (YOY) lake trout remain near the spawning ground through the first summer usually at depths of less than 120 ft (Eschmeyer 1956, 1964; GLFC 1957; Moffet, undated). No natural reproduction was observed during 1959-64 because sea lamprey predation and overfishing sharply reduced the abundance of adult trout. The first major plantings of hatchery reared juveniles were made in 1958, and some naturally spawned YOY were found in 1965. Natural reproduction is now most evident in Wisconsin waters (GLFC 1970a; USBCF 1969b). Areas where lake trout spawning has been reported in Lake Superior are described in greater detail below. Little information was available to permit description of lake trout nursery areas in Lake Superior.

Minnesota

The Minnesota shoreline was one of the major spawning grounds in the lake (Goode 1884). Lake trout spawned on rocky reefs all along shore, in 6-90 ft of water, in October and November (Cobb 1922; FWS 1979d; Kaups 1978; Surber 1920). The entire shoreline is still potential spawning area (Hassinger, pers. comm. 1979). From the 1930s to early 1950s, lake trout eggs for hatchery use were taken from fish netted during late September-early December; the greatest number of eggs was collected in late October-early November (Minn. DNR 1937-59).

M-1

Two Harbors (47°01', 91°40'). Lake trout in spawning condition were collected from the 1930s through 1942 in shallow rocky areas, at Fisherman's Point (47°02', 91°38') and at the mouth of Silver Creek (47°04', 91°36').

Lester River (46°50', 92°00')--Big Sucker Creek (46°55', 91°51'). Nets were set by fishermen throughout this area to catch spawners (Jackson, pers. comm. 1979; W. Johnson, pers. comm. 1979). Eggs were collected from the lake bottom in the area between French River (46°54', 91°53') and Schmidt Creek (46°54', 91°53'). Lake trout began moving onto reefs on about October 10. The redfin trout spawned earliest and the "silver, grey" trout spawned latest. A 5-6 in. thick layer of green "moss" covered the bottom in the bays in this area (W. Johnson, pers. comm. 1979). The French River was a spawn collection site during September-November (Ravenel 1898). In the early 1920s, one male and one female lake trout in spawning condition were taken off the mouth of the French River (Surber 1924).

M-2

Black Point (47°42', 90°33') (Koss and Koss, pers. comm. 1979; Zerbach, pers. comm. 1979).

Little Marais (47°24', 91°07'). In the early 1900s, many spawners were caught in this area (Koss and Koss, pers. comm. 1979). Presently, lake trout spawn during September-November at depths of 18-20 ft on reefs throughout the area, including Cedar Landing (47°24', 91°07'), Louie Hills Point (47°26', 91°04'), Little Marais Reefs (47°25', 91°06'), Manitou River (47°27', 91°04'), and Pork Bay (47°27', 91°02'). The first males move into spawning areas in late August; spent adults move to deeper water about 3 mi offshore (Fenstad, pers. comm. 1979).

Little Two Harbors (47°12', 91°22'). Spawning lake trout were collected in an area extending from the east side of Corundum Point (47°11', 91°23') to the 22 ft deep shoal area off Little Two Harbors. Fishermen collected spawning lake trout on rocky reef ledges on both sides of the unnamed point (47°11', 91°24'), immediately north of the Split Rock River mouth (47°11', 91°24'). Lake trout spawned on the nearshore reef at Twin Points (47°10', 91°25') (Sve, pers. comm. 1979).

Encampment Island (47°05', 91°33'). Lake trout concentrated here in September; the "redfin" lake trout spawned earliest (Croft, pers. comm. 1979). The rocky shoreline around the Encampment River was heavily fished (Kaups 1978).

M-3

Wauswaugoning Bay (47°58', 89°37'). Commercial fishermen caught spawners until 1955, over rubble and boulders at depths of 30-60 ft around Frances Island (47°59', 89°37'); eggs were also seen there on the bottom. Adult trout began moving into the bay at the end of August, and spawning peaked during mid-October-mid-November. Spawners were also found in the western part of Clark Bay (48°00', 89°33') and on the shoals of Susie Island (47°59', 89°34'), Lucille Island (47°58', 89°35'), and Belle Rose Island (47°58', 89°35') between Clark and Wauswaugoning Bays (Hassinger, pers. comm. 1979; Hendrickson, pers. comm. 1979). Siscowets spawned in the bay at depths of 400-600 ft (Hendrickson, pers. comm. 1979).

Grand Portage Bay (47°57', 89°40'). This area was heavily fished for spawning trout (Kaups 1978), and was a spawn collection site during September-November (Ravenel 1898). Fishing for spawners was conducted in the late 1940s or early 1950s on the reefs around Grand Portage Island (47°57', 89°40'), off Booth Rock (47°56', 89°41'), and at Twin Points (47°56', 89°43'). Most spawners were caught at depths of 24-60 ft but some were taken in water as shallow as 12 ft. Spawners entered the area in early October and left by November (Spry, pers. comm. 1979).

Grand Marais (47°45', 90°20'). Spawning occurred all along the shore in this area. Adults began moving inshore in mid-October, the movement peaked in November, often around election day, and the return to offshore water was completed in December. Redfin trout which spawned earlier than the "Mackinaw" trout, moved inshore during September or even late August; redfin trout have not been seen since 1936. Siscowets could be found spawning in summer in deep water (Koss and Koss, pers. comm. 1979). Specific areas in the vicinity of Grand Marais where fishing took place for spawners are:

> Chicago Bay (47°50', 89°58')--Red Rock Point (47°54', 89°46'). The reef in Big Bay (47°52', 89°55') was especially good; spawning and eggs were observed in shallow water (Koss and Koss, pers. comm. 1979). Young lake trout were seen in Cannonball Bay (47°53', 89°51') (Koss and Koss, pers. comm. 1979).
>
> Brule River (47°49', 90°03'). Many spawners were caught in November in nets set at depths of 10-30 ft just west of the river mouth, at Marr Island (47°48', 90°04'), and on Brule Reef (47°49', 90°13') (Zerbach, pers. comm. 1979).
>
> Kadunce Creek (47°48', 90°09'). Many spawners were caught at the mouth of the creek over large rocks. The bay substrate at the creek mouth was once covered with a 6-8 in. thick layer of moss; however this mossy cover disappeared many years ago (Zerbach, pers. comm. 1979).
>
> Guano Rock (47°46', 90°14'). Spawning occurs on rough rock bottom (Zerbach, pers. comm. 1979).
>
> Grand Marais Harbor (47°45', 90°20') and Powder Bay (47°45', 90°21') (Zerbach, pers. comm. 1979).
>
> Good Harbor Bay (47°43', 90°26'). Spawners were caught at depths of 12-60 ft at Rock Island (47°43', 90°25') and Gaff Hook Point (47°44', 90°23'). Dead eggs were observed in the bay after a storm (Zerbach, pers. comm. 1979).
>
> Cascade River (47°42', 90°31')--Terrace Point (47°43', 90°26'). This was the best place to obtain spawn from 1947 to the present. Eggs were seen in the area, and round whitefish were seen feeding on the eggs (Koss and Koss, pers. comm. 1979).

Wisconsin

Historically, lake trout spawned during October on almost every rocky area and reef along the shore, and throughout the Apostle Islands area (47°00', 90°40') (Coberly and Horrall 1980b; Daly et al. 1962; Goode 1884; King and Weigert, undated; Nevin 1896; Pycha, pers. comm. 1979; Swanson and King, pers. comm. 1979). Fishermen in the Apostle Islands referred to two types of "lean" lake trout: the Mackinaw or redfin trout, which spawned over rock in 18-20 ft of water and the "bank" trout, whose spawning grounds are unknown (Coberly and Horrall 1980b). In recent years, the heaviest spawning occurred in the eastern portion of the Apostle Islands (Tait 1973). Spawning generally takes place when the water temperature falls to 48-52°F (Pycha, pers. comm 1979).

Bark Point (46°53', 91°11'). This is an historical spawning area (Swanson and King, pers. comm. 1979) used by redfin trout (Coberly and Horrall 1980b).

Squaw Point (46°53', 91°05'). Redfin trout spawned here over rock bottom in 18-60 ft of water; spawning also occurred at Squaw Bay Caves (46°55', 91°01') (Coberly and Horrall 1980b).

Eagle Island Shoals (46°55', 91°03'). This is an historical spawning area (Swanson and King, pers. comm. 1979) that was also a spawn collection site (Coberly and Horrall 1980b).

Eagle Island (46°56', 91°02') (Coberly and Horrall 1980b).

Sand Island Shoals (47°00', 90°54'). This historical spawning area (Swanson and King, pers. comm. 1979) was relatively unproductive (Coberly and Horrall 1980b).

Point Detour (46°58', 90°51'). Historical spawning area (Coberly and Horrall 1980b; Swanson and King, pers. comm. 1979).

Raspberry Point (46°56', 90°48'). Historical spawning area (Coberly and Horrall 1980b).

York Island Shoals (47°01', 90°51'). Historical spawning area (Swanson and King, pers. comm. 1979).

Raspberry Island (47°58', 90°48') (Coberly and Horrall 1980b).

Bear Island Shoal (47°02', 90°49'). This historical spawning area (Pycha, pers. comm. 1979; Swanson and King, pers. comm. 1979) was quite productive in the early 1900s; thereafter its productivity declined (Coberly and Horrall 1980b).

Bear Island (47°01', 90°45'). Areas north (47°02', 90°46') and south (47°00', 90°45') of the island were spawning areas (Coberly and Horrall 1980b). The sand-bottomed area between Bear Island and Otter Island (47°00', 90°41') at depths of 4-25 ft was the second best nursery area in the Apostle Islands (47°00', 90°40') (Griswold 1970).

Devils Island Shoal (47°05', 90°42'). This was the second largest spawning area in Wisconsin; many spawners were caught here as late as 1950 (Coberly and Horrall 1980b), but the area has not had a spawning run since the late 1950s (Schram, pers. comm. 1979; Swanson and King, pers. comm. 1979). Spawning was reported to begin several days earlier than in other areas (Coberly and Horrall 1980b). This area is presently being stocked with eggs, fingerlings, and YOY (Horrall, pers. comm. 1979).

Rocky Island (47°02', 90°41'). Historical spawning area (Nourse, pers. comm. 1979).

North Twin Island (47°04', 90°35'). Shoals at both ends of the island are spawning areas (Coberly and Horrall 1980b; Nourse, pers. comm. 1979; Swanson and King, pers. comm. 1979).

Otter Island (47°00', 90°41') and Ironwood Island (47°00', 90°37') (Coberly and Horrall 1980b).

Cat Island (47°02', 90°33'). This is an historical spawning area; 75% of the spawners currently using the area are native fish (Coberly and Horrall 1980b; King and Belonger 1970; King and Swanson 1975; Pycha, pers. comm. 1979; Swanson and King, pers. comm. 1979). Young-of-the-year are also found here (Pycha, pers. comm. 1979).

Outer Island Shoal and Reef (47°05', 90°25'). This historical spawning area (Coberly and Horrall 1980b) is currently used (Pycha, pers. comm. 1979). Young-of-the-year were collected off the south end of the island during the 1950s (Dryer and King 1968; Eschmeyer 1956), and the west side of the island was reported to be a nursery area (Griswold 1970). Mackinaws spawned on the unnamed reef (47°03', 90°21') located 5 mi SE of the shoal and also 1-2 mi SE of this reef at depths of 108-120 ft; catches here were sometimes greater than at Gull Island Shoal (46°57', 90°24') (Coberly and Horrall 1980b).

Manitou Island Reef (46°57', 90°41'). This reef is currently used for spawning (Pycha, pers. comm. 1979; Swanson and King, pers. comm. 1979). Little Manitou Island (46°58', 90°41') is also a spawning area (Coberly and Horrall 1980b).

Oak Island Shoal (46°58', 90°43'). This is an historical spawning area (Coberly and Horrall 1980b; Pycha, pers. comm. 1979; Swanson and King, pers. comm. 1979), where YOY lake trout were found in late summer-fall (Pycha, pers. comm. 1979).

Stockton Island (46°56', 90°35'). Trout Point (46°58', 90°31') and Quarry Bay Point (46°55', 90°35') are historical spawning areas, which may presently be used (Coberly and Horrall 1980b; Pycha, pers. comm. 1979; Swanson and King, pers. comm. 1979).

Hermit Island (46°53', 90°41'). Spawning occurs over the rock and log remains of a dock (Swanson and King, pers. comm. 1979).

Basswood Island (46°50', 90°45'). An historical spawning area is located at the south end of the island (Pycha, pers. comm. 1979; Swanson and King, pers. comm. 1979). The area between Basswood and Madeline (46°50', 90°40') islands at depths of 90-150 ft was the best nursery area in the Apostle Islands (47°00', 90°40') (Griswold 1970).

Red Cliff Bay (46°53', 90°46') and Roys Point (46°51', 90°47') (Coberly and Horrall 1980b).

Madeline Island (46°50', 90°40'). Madeline Island Reef (46°51, 90°33') was a spawning area (Coberly and Horrall 1980b), and Big Bay (46°49', 90°38') is a nursery area (Griswold 1970).

Gull Island Shoal (46°57', 90°24')--Michigan Island Shoal (46°54', 90°27'). These shoals and the waters between them are the largest spawning area in the Apostle Islands (47°00', 90°40'); 75-80% of the spawners in this area are native lake trout (Dryer and King 1968; GLFC 1973, 1978; Harris and Eschmeyer 1974, 1975; Horrall, pers. comm. 1979; King and Swanson 1975; King and Weigert, undated; Pycha 1978, pers. comm. 1979; Pycha and King 1975; Rahrer 1968; Schram, pers. comm. 1979; Scott et al. 1978; Swanson 1976; Swanson and King, pers. comm. 1979; Swanson and Swedberg 1980; USBCF 1968). Spawning occurs at depths of 18-120 ft in October, and usually peaks during October 16-24 (Coberly and Horrall 1980b; Harris and Eschmeyer 1974; Pycha 1978, pers. comm. 1979; Rahrer 1968; Swanson and King, pers. comm. 1979). Young-of-the-year have been collected in the area (Pycha and Selgeby 1975).

Michigan Island (46°53', 90°29'). Spawning occurs on the northeast side of the island (Dryer and King 1968; Pycha, pers. comm. 1979); YOY were found there in late summer and fall (Dryer and King 1968; Griswold 1970; Pycha, pers. comm. 1979) indicating this is also a nursery area. Siscowets spawned about 3 mi SE of the island (Swanson, pers. comm. 1979).

Sand Cut Reef (46°44', 90°41'). A native population presently spawns here (Coberly and Horrall 1980b; King and Bèlonger 1970; King and Swanson 1975; Swanson and King, pers. comm. 1979).

Bayfield (46°49', 90°49'). Bayfield was a spawn collection site during September-November (Ravenel 1898). Spawning occurs over the sunken remains of an old coal dock south of town (Swanson and King, pers. comm. 1979).

Van Tassells Point (46°46', 90°52') (Coberly and Horrall 1980b; King and Belonger 1970; King and Swanson 1975; Swanson and King, pers. comm. 1979).

Bad River (46°38', 90°39'). Spawn was collected from fish taken off the river mouth in the early 1950s (Buettner 1961). The Bad River Reef (46°39', 90°39') was also a spawning site (Coberly and Horrall 1980b).

Marble Point (46°35', 90°30') (Coberly and Horrall 1980b).

Michigan

Spawning occurs in mid-October to early November, usually at temperatures of 48-54°F (Peck 1979a).

MS-1

Isle Royale (48°00', 88°50'). Fishermen historically identified this as one of the best spawning grounds in the lake (MSBFC 1895). The grounds were mainly off the south and southeast shores (Kumlien and True 1887; Organ et al. 1978). Hatchery spawn was collected mainly in October and November (Minn. DNR 1937-59; Ravenel 1898). In 1957, twice as many eggs were collected from Isle Royale as were taken from the Minnesota North Shore (Minn. DNR 1937-59). Most spawning begins in mid-October (Organ et al. 1978), but early runs of redfin trout, "humpers," and "halfbreeds" begin in mid-September (Cook 1929; Organ et al. 1978; Pycha, pers. comm. 1979; Rahrer 1965). [Authors' note: The terms "Mackinaw" and "redfin" trout are used synonymously for Wisconsin waters by Coberly and Horrall (1980b)]. Siscowets may spawn from June through November (Eschmeyer 1955).

Rock of Ages Reef (47°52', 89°19'). This is an historical spawning reef (Peck 1979a), where the "Rock of Ages" trout has spawned since the 1900s (Organ et al. 1978).

Washington Island (47°52', 89°15'). "Native" and redfin trout have spawned on the rock reef off the southwest end of the island since the 1900s (Organ et al. 1978). [Authors' note: For Michigan waters, Organ et al. (1978), use the terms "native" and "Mackinaw" trout synonymously.]

Washington Harbor (47°54', 89°11'). "Channel salmon" have spawned on rock and moss at the back of the harbor since the 1900s (Organ et al. 1978).

Cumberland Point (47°51', 89°14'). Native and redfin trout have spawned over rock around the point since the 1900s (Organ et al. 1978).

Rainbow Point (47°50', 89°11')--Isle Royale Light (47°57', 88°46'). Native and redfin trout have spawned over rock and moss along the entire southwest shore since the 1900s (Organ et al. 1978).

McCormick Reef (47°51', 89°02'), and McCormick Rocks (47°52', 88°57'). These are historical spawning areas (Peck 1979a) used by native and redfin trout since the 1900s (Organ et al. 1978).

Brandsford Reef (47°54', 88°52'). This is an historical spawning reef (Peck 1979a); native trout spawned here over rock and gravel (Organ et al. 1978).

Harlem Reef (47°54', 88°50'). This is an historical reef (Peck 1979a); native trout spawned here over rock (Organ et al. 1978).

Siskiwit Bay (47°57', 88°50'). Several spawning areas exist along the north shore of the bay.

Hay Bay Reef (47°56', 88°55'). This historical spawning reef (Peck 1979a), was used by native trout. Spawning also occurred around Little Siskiwit Island (47°57', 88°53') (Organ et al. 1978).

Domen and Doden Reef (47°58', 88°50'). This is an historical spawning reef (Peck 1979a); native trout spawned here over rock and gravel. Channel salmon spawned over rock and moss in Malone Bay (47°59', 88°49') since the 1900s (Organ et al. 1978).

North Shore (48°13', 88°25'--47°55', 89°11'). Native trout have spawned at four rocky areas along the shore since the 1900s; these areas are Todd Cove (48°02', 88°54'), a reef south of Gull Rocks (48°01', 88°57'), an unnamed area (48°01', 88°59'), and Finlander Reef (47°58', 89°05') (Organ et al. 1978).

Gull Islands (48°16', 88°16'). Siscowets, humpers (also called "paperbellies" or "popeyes"), and halfbreeds spawn here. Spawning may occur as early as June; in 1953, a nearly spent female, and a nearly ripe female were found in early June. Eggs have been taken from fish collected in mid-September at depths of 156-180 ft (Eschmeyer 1954; Goodier, pers. comm. 1979).

MS-2

Little Girls Point (46°37', 90°20'). This historical spawning area is now presently used almost exclusively by planted fish (Coberly and Horrall 1980b; FWS 1979d; Pycha, pers. comm. 1979). Spawning occurred in 1974 (Organ et al. 1978), and ripe and spent adults of both sexes were caught in 1975; the "reproductive potential" here is good (Peck 1976, 1979a).

Black River (46°40', 90°03')--Union Bay (46°50', 89°37'). Spawning presently occurs on rocky shorelines throughout the area (Wilson, pers. comm. 1979). Native trout spawned in the area from Presque Isle River (46°43', 89°58') to Union Bay until the 1950s (Organ et al. 1978). Planted trout have returned to spawn at planting sites in Black River Harbor (Peck 1979a).

West Ontonagon Reef (46°52', 89°24'). This reef was used for spawning until 1954 (Organ et al. 1978). The reproductive potential at this reef is fair, based on the capture of a few ripe and spent fish in 1975 (Nourse, pers. comm. 1979; Peck 1976, 1979a).

East Ontonagon Reef (46°54', 89°17'). Spawning occurred on rock and gravel prior to 1954 and again in 1974 (Organ et al. 1978). Although ripe fish were collected during the mid-1970s (Nourse, pers. comm. 1979), the reproductive potential at the reef presently is poor (Peck 1976, 1979a).

Fourteen Mile Point (47°00', 89°07'). Spawning occurred here until 1954 (FWS 1979d; Organ et al. 1978). A few ripe adults were collected in the mid-1970s (Nourse, pers. comm. 1979), but the reproductive potential presently is poor (Peck 1976, 1979a).

MS-3

Redridge (47°09', 88°46'). Spawning occurred from 1917 through the 1960s, over rock extending 5-6 mi N along shore from Redridge (Organ et al. 1978).

West Upper Entry Reef (47°14', 88°39'). Spawning occurred here from the early 1900s through 1972, but the reproductive potential presently is poor (Organ et al. 1978; Peck 1976, 1979a).

East Upper Entry Reef (47°15', 88°36'). Spawning has occurred from the early 1900s through 1972 (Organ et al. 1978), but the reproductive potential is presently poor (Peck 1976, 1979a). Until 1972, siscowets spawned about 4 mi offshore in 400 ft of water in early July (Organ et al. 1978).

Hutchinson Shoal (47°23', 88°24')--Great Sand Bay (47°26', 88°15'). Lake trout spawned along shore from Hutchinson Shoal to Great Sand Bay during 1916-1975 (Organ et al. 1978). Hutchinson Shoal, an historical spawning reef (Nourse, pers. comm. 1979; Peck 1976, 1979a), was used in 1975 (Organ et al. 1978). Eagle River Shoals (47°26', 88°18'), is also an historical spawning reef; few ripe fish have been caught here recently, and the reproductive potential presently is poor (Nourse, pers. comm. 1979; Peck 1976, 1979a). Ripe fish were collected on the shoals of Great Sand Bay during October in the early 1970s (Nourse, pers. comm. 1979).

Eagle Harbor (47°28', 88°09')--Agate Harbor (47°28', 88°03'). Spawning occurred over rock in this area since 1963 (Organ et al, 1978; Wilson, pers. comm. 1979). Little Grand Marais Harbor (47°28', 88°06') is an historical spawning reef, where reproductive potential presently is excellent, based on collections of ripe and spent fish (Nourse, pers. comm. 1979; Peck 1976, 1979a).

Devils Wash Bowl (47°29', 87°57'). A traditional reef between Agate Harbor (47°28', 88°02') and Copper Harbor (47°28', 87°54') (Peck 1976, 1979a).

Copper Harbor Reef (47°29', 87°52'). This is an historical spawning area (Peck 1976, 1979a; Wilson, pers. comm. 1979); spawning grounds were located both inside and outside the harbor (Van Oosten 1938b). Spawning has occurred here since 1917 (Organ et al. 1978), and the reproductive potential is good, based on the capture of ripe males and females (Nourse, pers. comm. 1979; Peck 1976, 1979a).

Keweenaw Point (47°24', 87°43'). This is an historical spawning reef (Peck 1976, 1979a); spawning occurred here from 1916 through the 1970s (Organ et al. 1978). Fishermen reported one of the best spawning grounds to be at the head of the point (MSBFC 1895).

Manitou Island (47°25', 87°37'). This is an historical spawning area (Peck 1976, 1979a; Van Oosten 1938b; Wilson, pers. comm. 1979), which fishermen identified as one of the best (MSBFC 1895). Spawning occurred all around the island (Peck 1976), and especially on the shoals on the south side (Nourse, pers. comm. 1979). Spawning has occurred here since 1917 (Organ et al. 1978), but the reproductive potential is poor, based on the low numbers of spawners caught (Peck 1976, 1979a).

Port Gentre (location unknown). A reef 4 mi offshore was a major spawning ground (Goode 1884).

Point Isabelle (47°21', 87°56'). This is an historical spawning reef (Peck 1976, 1979); spawning has occurred here since 1916 (Organ et al. 1978). The reproductive potential based on the presence of ripe and spent fish is excellent (Peck 1976, 1979a). Bete Grise Bay (47°23', 87°56') was also a major spawning area (Goode 1884).

Betsy Reef (47°18', 88°03'). This historical spawning reef (Peck 1976, 1979a) was used by native trout until the 1950s (Organ et al. 1978).

Gay (47°14', 88°10'). Native and redfin trout spawned over a rock reef (47°15', 88°07') north of Gay (Organ et al. 1978), and spawning has occurred since 1916 at Buffalo Reef (47°12', 88°12') (Organ et al. 1978; Peck 1976, 1979a). The reproductive potential at Buffalo Reef is considered to be excellent, based on the presence of ripe and spent lake trout and the presence of lake trout eggs in the stomachs of other fish in 1975 (Peck 1976, 1979a); many ripe and spent lake trout were also found here in 1977 (Stauffer 1978).

Traverse Point (47°08', 88°14'). This historical spawning area (Peck 1976, 1979a) was used from the 1900s through 1969 (Organ et al. 1978).

Hallberg Reef (47°07', 88°10'). This historical spawning reef located in just over 100 ft of water has poor reproductive potential (Peck 1976, 1979a). A rock and gravel area used for spawning from 1916 through 1970s extends north from the reef for about 5 mi (Organ et al. 1978).

Red Rocks Reef (47°07', 88°17'). Spawning has occurred on this reef, at least since the 1900s (Organ et al. 1978; Peck 1976, 1979a). The reproductive potential here is excellent, based on the presence of ripe and spent adults and of lake trout eggs in the stomachs of other fish (Peck 1976, 1979a).

Traverse Island (47°04', 88°16'). This is an historical spawning area (Peck 1976, 1979a; Pycha, pers. comm. 1979), where the reproductive potential is excellent (Peck 1976, 1979a). Spawning has occurred since 1916 over a rock and gravel shoal area (47°03', 88°13') 3 mi SE of the island in 85-100 ft of water (Organ et al. 1978).

Trout Reef No. 1 (47°01', 88°19'). This historical spawning area (Peck 1976, 1979a) was used in 1975 (Organ et al. 1978), but reproductive potential here is poor (Peck 1976, 1979a). Spawning also occurred from

1917 through the 1960s, along the mainland shore adjacent to the reef from 47°00', 88°23' to 47°02, 88°21' (Organ et al. 1978). Fair numbers of YOY were found in this area in August 1952 (Eschmeyer 1956).

Trout Reef No. 2 (46°56', 88°25'). This historical spawning area (Peck 1976, 1979a) was used in 1975 (Organ et al. 1978), but the reproductive potential here is poor (Peck 1976, 1979a).

Keweenaw Bay (46°58', 88°20'). Native trout spawned over rock, just north of the town of Keweenaw Bay (46°52', 88°29') during the 1940s (Organ et al. 1978).

Pequaming Point Reef (46°52', 88°22'). This historical spawning reef (Peck 1979a) was used until the 1960s and then again in 1975 (Organ et al. 1978). The reproductive potential here is good, based on collections of mature males and females (Peck 1976, 1979a).

Sand Point (46°47', 88°28'). Planted trout have spawned over rock and gravel from Sand Point along shore to 46°50', 88°29' since 1970 (Organ et al. 1978).

L'Anse (46°46', 88°27')--Pequaming Bay (46°50', 88°24'). This shoreline was a spawning area; the reef area (location unknown) off L'Anse (Goode 1884) and the area between Rock Beach (location unknown) and Pequaming (46°51', 88°24') (Van Oosten 1938b) were used most intensively. Planted trout have spawned over rock along shore in this area since 1970 (Organ et al. 1978).

Point Abbaye Reef (46°58', 88°06'). This spawning reef (Nourse, pers. comm. 1979; Peck 1979a; Van Oosten 1938b) has been used since 1916; spawning occurs from mid-October to late November, from shore out to a depth of about 90 ft (Organ et al. 1978). The reproductive potential of the reef presently is good (Peck 1976, 1979a).

Huron Islands Reefs (46°57', 87°58'). This historical spawning area (FWS 1979d; Peck 1979a; Wilson, pers. comm. 1979) has been used since 1916 (Organ et al. 1978). Spawning occurred between the islands and the mainland (Van Oosten 1938b). The reproductive potential is good (Peck 1976, 1979a).

Huron River Point (46°55', 87°54')--Salmon Trout Point (46°52', 87°44'). Spawning occurred on all rocky bottoms in nearshore areas along this shoreline (FWS 1979d; Wilson, pers. comm. 1979). Spawning occurred at Huron River Point from 1916 to 1975 (Organ et al. 1978), but the reproductive potential is poor (Peck 1976, 1979a). Conway Point (46°52', 87°47') was used from 1916 to the 1970s and Salmon Trout Point from 1917 to the 1960s (Organ et al. 1978). A spawning run entered the Salmon Trout River (46°52', 87°46') in late summer (Hubbs 1929).

MS-4

Big Bay Point (46°51', 87°41'). This historical spawning reef (Peck 1977, 1979a) was used from 1916 to the 1970s (Organ et al. 1978). The reproductive potential is excellent, based on the presence of ripe and spent adults and of lake trout eggs in the stomachs of other fish (Peck 1975b, 1979a). Spawn was collected from fish in Big Bay during the early 1900s (Anderson 1910-26).

Yellow Dog Point (46°49, 87°38')--Sauk Head (46°43', 86°34'). This shoreline was used for spawning from 1917 to the 1960s (Organ et al. 1978). Sauk Head was a major spawning ground (Goode 1884).

Sauk Head (46°43', 86°34')--Marquette (46°33',87°23'). Several areas between Sauk Head and Marquette were used for spawning. Garlic Island Reef (46°44', 87°32') is an historical spawning area where reproductive potential is excellent (Peck 1975b, 1979a); native trout spawned here in 1974 (Organ et al. 1978). Spawn was taken from fish collected at Sauk Head and at Thoney Point (46°41', 87°31') during the early 1900s (Anderson 1910-26). Spawning occurred between Thoney Point and Little Garlic River (46°41', 87°31') (Organ et al. 1978). Granite Island (46°43', 87°25') and Granite Point (46°38', 87°27') are spawning areas (Nourse, pers. comm. 1979); spawn was collected at Granite Point in the early 1900s (Anderson 1910-26). Partridge Island Reef (46°37', 87°25') is an historical spawning reef (Peck 1975b, 1979a); planted trout reportedly spawned here in 1973 and 1974 (Organ et al. 1978), and the reproductive potential is excellent, based on the presence of ripe and spent adults and of lake trout eggs in the stomachs of other fish (Peck 1974b, 1975b, 1979a). Two newly-hatched fry and one egg were found at a depth of 60 ft in this area in March 1953 (Eschmeyer 1955). Presque Isle (46°35', 87°23) was a major spawning ground (Goode 1884), where spawn was collected (Anderson 1910-26). Lake trout were most abundant at Marquette during October, when they came inshore to spawn (Smith and Snell 1891). Fishermen's records for years 1910-26 show that spawn from ripe and spawning adults in this area was taken from mid-October to early November with largest collections in the third and fourth weeks of October. The adults at this time were over rocky substrate in waters shallower than 60 ft (Anderson 1910-26). During the late 1920s, spawning occurred at Marquette during October 16-November 6 (Van Oosten 1927a). Historically, the earliest run at Marquette occurred in October and was composed of "shoal" trout (Cook 1929). In the early 1950s, the density of adults on the spawning grounds north of Marquette was highest during October 10-November 4 (Eschmeyer 1955). Siscowets spawned in December off Marquette over mud bottoms at depths of 420-600 ft (Smith and Snell 1891) and spawned in the Marquette area in July at depths of at least 120 ft (Van Oosten 1938b).

At Marquette, planted lake trout spawned successfully for the past few years on rocky areas at the intake and discharge structures of the Presque Isle Power Station in Presque Isle Harbor (46°34', 87°23'). Adults are present in the harbor from early September to December and spawn in mid-October to early November at a water temperature of about 50°F. Concentrations of spawning adults have been seen, eggs have been collected from gravel and rock bottom, and fry have been collected from early April through July. Fry remain in nearshore areas until mid-July and then move to deeper water (Brown 1977; GLFC 1977b; Organ et al. 1978; Peck 1978, 1979b; Rybicki and Keller 1976; Stauffer 1979b; Stauffer and Peck 1977; Stauffer et al. 1976; Stauffer and Wagner 1976; Wagner 1974b;

Wapora 1976b). Spawning also occurs on two natural rock reefs, one 2,500 ft E and another 4,000 ft SE of the mouth of the Dead River (46°34', 87°23') (Peck 1978, 1979b; Stauffer 1978b, 1979b).

Stannard Rock (47°11', 87°14'). Fishermen identified this as one of the best spawning areas (Kumlien and True 1887; MSBFC 1895). The grounds were reported to extend 10-12 mi out in every direction (Kumlien and True 1887). Spawn was collected from fish during the early 1900s (Anderson 1910-26). Native lake trout are presently abundant here, and the population is self-sustaining (Pycha, Swedberg, and Nourse, pers. comm. 1979).

Shot Point (46°30', 87°10'). Spawn was collected here from fish in the early 1900s (Anderson 1910-26). This spawning area is currently used (FWS 1979d; Nourse and Pycha, pers. comm. 1979).

Laughing Fish Point (46°32', 87°01'). This area, along with the associated reef (46°32', 86°59'), is an historical spawning area (Eschmeyer 1955, 1956; Peck 1975b, 1979a; Pycha and Nourse, pers. comm. 1979), where spawn was collected (Anderson 1910-26). Planted fish spawned here in 1973 and 1975 (Organ et al. 1978), and the reproductive potential is excellent, based on the presence of ripe and spent males and females and of lake trout eggs in the stomachs of other fish (Peck 1974b, 1975b, 1979a). Young-of-the-year were collected in August 1952 and June-October 1953 over a sand bottom at depths of less than 120 ft just outside the rocky spawning reef; they were more abundant here in 1953 than in any other area sampled in the lake (Eschmeyer 1955, 1956). Laughing Fish Island (location unknown) was a major spawning site (Goode 1884).

Sharp Point (location unknown). A major spawning site (Goode 1884).

Au Train Island (46°29', 86°54'). Brownstone Reef (46°28', 86°53) and Au Train Island Reef (46°30',86°54') are historical spawning areas (Organ et al. 1978; Peck 1975b, 1979a); spawn was collected from fish on these reefs and in Au Train Bay (46°27', 86°51') in the early 1900s (Anderson 1910-26). Spawning occurred during the latter half of October (Van Oosten 1927a). Based on the presence of ripe and spent adults and of lake trout eggs in the stomachs of other fish, the reproductive potential is excellent at Au Train Reef and good at Brownstone Reef (Peck 1975b, 1979a).

Munising (46°25', 86°39). Spawning occurred along the rock shoreline from Au Train Point (46°29', 86°48') to Five Mile Point (46°28', 86°44') and around Williams Island (46°29', 86°43') and, in 1974, at Wood Island (46°31', 86°44') (Organ et al. 1978). Spawning occurred during October at Williams Island Reef (46°28', 86°43') (Van Oosten 1927a). Wood Island Reef (46°31', 86°45') is an historical spawning area; the run declined here in the late 1950s, but the reproductive potential presently is fair (FWS 1979d; Peck 1979a). Spawning occurred historically at Wood Island Shoal (46°35', 86°46'), at depths of 50-75 ft (Peck 1975b, 1979a); spawning occurred there in 1974 (Organ et al. 1978), but only a few ripe and spent adults have been found and reproductive potential presently is poor (Peck 1975b, 1979a). Spawning occurred during October-early November at Trout Point Reef (46°30', 86°36') (Van Oosten 1927a). In 1953, very few YOY were collected around Grand Island (46°30', 86°40') in August (Eschmeyer 1956).

Grand Portal Point (46°33', 86°29'). This historical spawning reef (FWS 1979d; Organ et al. 1978; Peck 1975b, 1979a) supported a large spawning run until the late 1950s (Pycha, pers. comm. 1979). Spawning here usually occurred from mid-October to early November (Van Oosten 1927a). The reproductive potential is excellent based on the presence of ripe and spent males and females and of lake trout eggs in the stomachs of other fish (Peck 1975b, 1979a).

MS-5

Beaver Hump (46°37', 86°21'). This historical spawning reef is located at a depth of 72-108 ft (Organ et al. 1978; Peck 1979a; Pycha, pers. comm. 1979). Spawning occurred here from mid-October to early November and also at the same time along the adjacent mainland shore including the Pictured Rocks area (Van Oosten 1927a).

Au Sable Point Reef (46°41', 86°09'). This is an historical spawning reef (FWS 1979d; Peck 1977, 1979a; Pycha, pers. comm. 1979). Planted fish spawned here in 1974 (Organ et al. 1978), but based on the numbers of ripe adults present, the reproductive potential is poor (Peck 1977, 1979a).

Grand Marais Reef (46°42', 86°02'). This is probably the "Big Reef," which was fished out of Grand Marais (46°40', 85°59') from mid-October to early November (Van Oosten 1927a). The reproductive potential of the Grand Marais Reef is presently poor (Peck 1977, 1979a). In 1974, planted trout spawned at the mouth of Sable Creek (46°40', 86°01') (Organ et al. 1978). Lake trout also spawn on any shoal or hump between Grand Marais and Caribou Island (47°22', 85°49') at depths of 180 ft or less including Southwest Bank (47°14', 85°59'), Southeast Bank (47°15', 85°47') and the unnamed 155-185 ft deep shoal at 47°06', 85°52' (Pycha, pers. comm. 1979).

Grand Marais (46°40', 85°59')--Little Lake (46°43', 85°22'). Lake trout spawn along the shoreline over gravel at depths of 12-18 ft (Organ et al. 1978).

MS-6

Crisp Point (46°45', 85°16'). Native lake trout spawned on the 30 ft deep shoal just off the point, until the 1930s (FWS 1979d; Organ et al. 1978).

Tahquamenon Island (46°32', 84°57'). Spawning occurred historically on the shoals around the island and north for about 4 mi (Organ et al. 1978; Peck 1979a), during October (Van Oosten 1927a).

Salt Point Reef (46°28', 84°50'). Native trout spawned here historically (Organ et al. 1978; Peck 1979a) during October (Van Oosten 1927a).

Iroquois Island Reef (46°30', 84°40'). The extensive shoal area around the island and off Nadoway Point (46°29', 84°41') and Iroquois Point (46°29', 84°38') was used historically for spawning by native lake trout (FWS 1979d; Organ et al. 1978; Peck 1979a) in October (Van Oosten 1927a).

Ontario

Many populations of lake trout exist in the Ontario waters of Lake Superior. At least three major types of lake trout ("deep, fat," "banker," and "shallow water" trout) are recognized (Loftus 1954b). Several populations also make spawning runs into tributaries. Eight rivers along the eastern shore support runs, which occur over a 2-week period sometime in September and October. Spawners may move in and out of a river several times during a run. Adults usually remain near the river in which they spawn, but a few range as far as 50 mi during the year. Young-of-the-year appear to move into the lake soon after hatching (Loftus 1954b, 1958; OMNR 1976b).

OS-1

Thunder Bay (48°25', 89°00'). Commercial fishermen reported that redfin, "black," "grey," and little grey trout spawned in the bay (Goodier, pers. comm. 1979). Spawning usually occurs during September 25-December 1 (MacKay 1956b, 1969). Spawning occurred at the following locations (Goodier, pers. comm. 1979):

> Flatland Island (48°13', 89°14'). Spawning occurred on the north and west sides of the island from about mid-September to October 5. Pie Island (48°14', 89°07'). Native redfins and large grey trout spawned in October at depths of 12 ft or less on the north side and at Keefer Point (48°13', 89°10'). Redfin trout also spawned in areas such as Turtle Head (48°15', 89°02') beginning about October 20. Wyllie Point (48°11', 89°16')--Squaw Bay (48°18', 89°14'). An early run of little grey trout spawned here. Grand Reef (48°18', 89°11'). Spawning occurred on about September 25. Welcome Island (48°21', 89°08'). Schwitzer Shoal (48°23', 89°03'). This was a very good spawning area. Port Arthur Harbor breakwall (48°27', 89°12'). Black trout spawned here. Papoose Island (48°29', 89°02'). Spawning occurred on the shoal area (48°29', 89°02') just northwest of the island. Mary Island (48°30', 88°59'). Spawning occurred along the southwest shore. Buck Island (48°31', 88°55'), Keshkabuon (Caribou) Island (48°31', 88°51'), and Hare Island (48°19', 88°58').

Thunder Cape (48°19', 88°55'). Spawning occurred along the east side of the cape, at the Tee Harbour (48°19', 88°53') peninsula, and at Silver Islet Landing (48°19', 88°49') (Goodier, pers. comm. 1979).

Clark Island (48°20', 88°43') and Carney Rock (48°21', 88°43') (Goodier, pers. comm. 1979).

OS-2

Black Bay (48°40', 88°30'). Most spawning in the bay was limited to the mouth of the bay, south of George Point (48°29', 88°36') on the east shore, and south of Foster Point (48°23', 88°43') on the west shore; the rest of the bay has a sandy bottom. Spawning areas included are (Goodier, pers. comm. 1979):

> Foster Point (48°23', 88°43'). Foster Point and south along Middlebrun Channel (48°22', 88°43'). George Point (48°29', 88°36'). May have been a spawning area of minor importance. Cowie Point (48°27', 88°35'), Seagram Rock (48°26', 88°34'), and Magnet Point and Magnet Island (48°24', 88°34'). Edward Island (48°23', 88°38'). The west side of the island and Edward Harbour (48°22', 88°39'). Hardscrabble Island (48°21', 88°40'). Porphyry Island (48°21', 88°38'). Most spawning occurred in the Point Porphyry area (48°20', 88°39'). Gravel Island (48°21', 88°43'). Was a minor spawning area.

OS-3

Nipigon Bay (48°53', 87°50'). Only parts of Nipigon Bay proper were important lake trout spawning areas. A stock of "black-colored" trout is believed to have resided in the bay. Lake trout spawned 8-10 days later in Nipigon Bay than in the lake proper. Spawning areas in the bay were: Cooper Point (48°59', 88°04;'), the rocky shoreline between Jackpine River (48°58', 88°00') and MacInnes Point (48°56', 87°56'), Clay Shoal (48°56', 88°11'), and Holden Shoal (48°57', 88°09), the reefs between Ile La Grange (48°56', 88°08') and Outan Island (48°54', 88°07'), the southwest shore of Vert Island (48°56', 88°04'), Burnt Point (48°52', 87°56'), the shoreline from Cavers Bay (48°53', 87°40') to Crow Point (48°51', 87°39'), the east shore and mossy area at the northwest end of Salter Island (48°47', 87°34'), the east end of Anguros Island (48°51', 87°35'), and the eastern shore of Pays Plat Bay (48°52', 87°33') to Rossport Point (48°49', 87°33') (Goodier, pers. comm. 1979).

Rossport (48°50', 87°31'). This was a spawn collection site (Ravenel 1898). Red trout spawned around Whiskey Island (48°49', 87°31'). Spawning also occurred on Spider Reef (48°49', 87°24') at the northeast end of Channel Island (48°48', 87°29') and at a mossy area (48°49', 88°30') off the northwest shore of the island (Goodier, pers. comm. 1979). Ripe and running males and females were more recently collected from the channels among the Rossport Islands (48°50', 87°31') (FRBC 1968).

OS-4

Magnet Point (48°24', 88°34')--Herron Point (48°35', 88°15'). Many of the islands just outside Sturgeon Bay (48°32', 88°26') and Shesheeb Bay (48°34', 88°19') supported spawning, including the Borden Island-Gourdeau Island (48°31', 88°22') area, Barclay Island (48°28', 88°28') area, and Stanton Island (48°30', 88°27'). The northern shoal area of Shaganash Island (48°26', 88°28') was used mainly by black trout (Gollat 1976; Goodier, pers. comm. 1979). No spawning occurred in Sturgeon Bay proper because the bottom is mud (Goodier, pers. comm. 1979). Herron Point also was a spawning area, as was Bateau Rock (48°16', 88°06') (Goodier, pers. comm. 1979).

Island Area (48°39', 88°05'--48°46', 87°30') off the mouth of Nipigon Bay (48°53', 87°50'). The island shoals at the mouth of Nipigon Bay historically were extensive and important spawning grounds. Several varieties of lake trout spawned among the islands. Runs of black trout appeared first, followed by "red" and redfin trout in early October, as the black trout were beginning to leave. These were followed by large "yellowfin" trout and then finally by very large grey trout, which spawned in late November and December. Specific locations are as follows (Goodier; pers. comm. 1979, unless otherwise noted):

> Fluor Island (48°39', 88°06'). Spawning occurred all along the southeast shore and also on the inside, protected shores of Cedar (48°38', 88°06'), Provost (48°38', 88°05'), Tremblay (48°38', 88°04'), Willard (48°39', 88°05'), and Puff Islands (48°39', 88°03').
>
> St. Ignace Island (48°48', 87°55'). Lake trout spawn was collected here (Ravenel 1898). Ripe and running adults were collected here in 1967 (FRBC 1968). This was one of the best spawning areas in the entire lake; almost the entire south shore, including every island and shoal, was used (Gollat 1976). Spawning areas were: the tip of Newash Point (48°41', 88°01') and Devil's Gap Shoal (48°41', 88°01'), Longcroft Island (48°41', 87°59'), Angelica Island (48°42', 87°58'), Talbot Island (48°42', 87°57'), Agate Island (48°42', 87°59'), Owl Island (48°43', 87°59'), Paradise Island (48°43', 87°58'), Bowman Island (48°44', 87°59'), reportedly the best area on St. Ignace, Nest Island (48°45', 87°56'), Fraser Point (48°45', 87°55'), Hope Island (48°45', 87°54'), the shoals between Hope and Burnet islands (48°45', 87°53'), Armour Island (48°45', 87°52'), the bay (48°45, 87°48') south of French Harbour (48°45', 87°48'), St. Joe Islands (48°45', 87°47'), Bignell Point (48°45', 87°48'), St. Ignace Harbour (48°46', 87°47'), the southwest shore of Bead Island (48°46', 87°46'), Moffett Strait from Grotto Point (48°45', 87°45') to south of Wickham Bay (48°46', 87°43').
>
> Simpson Island (48°47', 87°40'). Spawning occurred along the entire south shore from Grebe Point (48°44', 87°42') to Morn Point (48°45', 87°36'), on rock or gravel shoals.
>
> Salter Island (48°47', 87°34'). Chubby Harbour (48°47', 87°33') was an excellent spawning area, as was the north shore of Battle Island (48°45', 87°33').
>
> Wilson Island (48°46', 87°29'). Spawning occurred along the entire west shore and the north shore of Cobinosh Island (48°45, 87°29').
>
> Copper Island (48°46', 87°24'). Southeast point.

OS-5

Worthington Bay (48°46', 87°15')--Santoy Bay (48°46', 86°54'). Spawning occurred along this shoreline, at Almos Shoal (48°46', 87°04'), Lawson Island (48°45', 86°55'), Jack Rock (48°46', 86°55'), in Worthington Bay, in Moberly Bay (48°48', 87°00') which was a minor spawning area for large salmon trout, and in the northeast inlet (48°49', 86°58') of Jackfish Bay. No trout were found in the fall in Terrace Bay (48°46', 87°10') (Goodier, pers. comm. 1979). At Jackfish (48°48', 86°58'), a run of ripe grey and black trout occurred August 15-September 15, and large salmon trout arrived on about November 1 (Ont. Game Fish 1912).

Slate Islands (48°40', 87°00'). Spawning occurred throughout the islands (Goodier, pers. comm. 1979).

Leadman Islands (48°41', 86°56'). Spawning occurred here (Goodier, pers. comm. 1979).

Ashburton Bay (48°46', 86°42'). Spawning occurred at McKellar Harbor (48°48', 86°43') at the head of the bay, at Fitzsimmons Rocks (48°46', 86°45'), and to the southwest along shore for about 3 mi (Goodier, pers. comm. 1979).

Pic Island (48°42', 86°37')--Playter Harbour (48°35', 86°16'). An important fishery for siscowets was carried out from Port Coldwell (48°45', 86°32') (Koelz 1926). "Fat" trout probably spawned on Uncle Bob's Bank (48°41', 86°27'). Black and yellowfin trout moved onto some of the shoals and islands east of Pic Island such as Detention Island (48°44', 86°31') and into Thompson Channel (48°43', 86°36') in August and probably spawned in these areas or near Port Coldwell Harbor and Detention Island. Spawning occurred at Port Munro (48°46', 86°26'), Ypres Point (48°44', 86°27'), Peninsula Harbor (48°44', 86°24'), along shore around Craigs Pit (48°41, 86°22'), Randle Point (48°39', 86°21'), Heron Bay (48°38', 86°20'), Ogilvy Point (48°36', 86°21'), and the points outside Playter Harbour (Goodier, pers. comm. 1979). Lake trout also spawned in the mouth of the Pic River (48°36', 86°18') (OMNR 1976b).

Superior Shoal (48°03', 87°07'). Historically this was a spawning area for lean trout, fat trout, halfbreeds, and humpers (paperbellies); humpers spawned here in late July to mid-August (Goodier, pers. comm. 1979; Loftus 1952).

OS-6

Sewell Point (48°26', 86°14')--La Canadienne Point (48°01', 85°57'). Almost every shoal and point along the shoreline supported spawning, including Stench Rock (48°16', 86°10'), the islands off the White Spruce River (48°17', 86°09'), and Otter Island (48°06', 86°03'). The shoreline from Otter Head (48°05', 86°01') to La Canadienne Point was one of the best inshore spawning areas on the east shore. Spawning runs entered the White Gravel River (48°18', 86°10') and Swallow River (48°10', 86°05'), and spawning occurred at the mouth of the Falls River (48°08', 86°03') (Goodier, pers. comm. 1979).

Puckasaw (Pukaskwa) River (48°00', 85°53')--Michipicoten Bay (47°57', 84°52'). A major spawning run entered the Puckasaw River and spawning also occurred along shore around the river mouth (Goodier, pers. comm. 1979; Loftus 1954a, 1955; OMNR 1976b; Speirs 1955b). This was the earliest tributary run and occurred in early September (Goodier, pers. comm. 1979; Loftus 1952). The fish climbed steep rapids to reach the spawning site 1/2 mi upstream, below a waterfall (Loftus 1958). A "beach" trout came inshore northwest of Puckasaw (48°01', 85°55') on October 15-20 and a "sand" trout at Puckasaw October 20-November 30 (Loftus 1952). Spawning occurred along shore about 5 mi S of the Puckasaw River (47°57', 85°47'), at Ganley Harbor (47°56', 85°43'), the mouth of the Pipe River (47°56', 85°41'), where a minor run occurred, and Pilot Harbor (47°55', 85°35'). Runs occurred at the mouth of the Ghost River (47°55', 85°26') and in the Eagle (47°56', 85°22'), University (Dog) (47°58', 85°12'), and Makwa (Bear) (47°57', 85°04') rivers; spawning also occurred along shore near these river mouths (Goodier, pers. comm. 1979; Loftus 1952, 1955, 1958; Spiers 1955b). The run entered the Eagle River in mid-September (Loftus 1952), and spawning occurred at the foot of the second rapids (Loftus 1958). The University River run persisted from mid-September until October 1, and the fish ascended several steep rapids to reach the spawning site 2 mi upstream, at the foot of a waterfall (Goodier, pers. comm. 1979; Loftus 1952, 1958). The Bear River run occurred during the third and fourth weeks in September (Loftus 1952). Spawning also occurred around Minnekona Point (47°57',85°00') and around Dore' Point (47°57', 84°58'). In the Michipicoten River (47°56', 84°51'), the run moved upstream as far as 10 mi; this run was first recorded in 1850. Fat trout spawn during October in an area (47°51', 85°18') 360-390 ft deep extending 4-10 mi offshore between the Eagle and Dog Rivers (Goodier, pers. comm. 1979).

Old Woman Bay (47°47', 84°54')--Cape Gargantua (47°36', 85°02'). Spawning occurred throughout this area. A minor run entered the Old Woman River (47°47', 84°54') (Goodier, pers. comm. 1979). A fishery preserve maintained in the vicinity of Gargantua (47°35', 84°58') was one of the best spawning grounds in the lake (Ont. Game Fish 1911).

Michipicoten Island (47°45', 85°47'). Spawning, primarily by large redfin trout, occurred around most of the island and on the Clay Banks (47°48', 85°51') and The Shingles (Bank) (47°47', 85°52'). The best spawning areas were along the northwest shore, where large "shore" trout came in during early November, and along the south shore. Spawning also took place among The Breeders (47°42', 85°54') and other islands off the south shore (Goodier, pers. comm. 1979; Loftus 1952). Spawn collection began on about September 15 (Ravenel 1898).

Caribou Island (47°22', 85°49'). Spawning occurs during the first 3 weeks of October (Goodier, pers. comm. 1979; Loftus 1952; Peck 1975a; Rahrer 1965) and also in late November (Loftus 1952) at depths of 30 ft or less (Goodier, pers. comm. 1979). Males in spawning condition have been collected here in September (Mich. DNR 1968a).

Klondike Bank (location unknown, near Caribou Island). Ripe humpers and siscowets were taken here in early October 1973 (Stauffer 1974c).

OS-7

Cape Gargantua (47°36', 85°02')--Agawa Bay (47°21', 84°39'). Spawning occurs on the south side of Devils Warehouse Island (47°34', 85°00'), at Gull Island Shoal (47°29', 84°56), Leach Island (47°27', 84°56'), Rowe Island (47°26', 84°48'), Lizard Islands (47°25', 84°49'), and along the shoreline between Robertson Cove (47°27', 84°46') and the Sand River (47°26', 84°44'). The Sand River had a spawning run; the Baldhead (Gravel) River (47°29', 84°50') has a spawning run in late September (Loftus 1952; OMNR 1976b). In 1912, suckers destroyed lake trout spawn in Agawa Bay (Ont. Game Fish 1912).

Montreal River (47°15', 84°39'). Runs enter the river between late September and mid-October and progress 200 yd upstream to a spawning area, where the stream bottom consists of boulders and gravel. Spawning also occurs at the river mouth (Baldwin 1956; Budd 1954; Goodier, pers. comm. 1979; Loftus 1952, 1954a,b, 1955, 1958; MacKay 1956b, 1969; OMNR 1976b; Speirs 1955). Lake trout also spawn around Montreal Island (47°14', 84°43') (Environ. Can. 1977c).

Theano Point (47°11', 84°42')--Corbiel Point (46°53', 84°37'). Spawning occurs along almost the entire shoreline and on several offshore shoals, including Siesta Shoal (47°08', 84°51'), Mica Shoal (47°06', 84°50'), Rousseau Bank (47°01', 84°53'), Pancake Shoal (46°55', 84°48'), and Outer Pancake Shoal (46°54', 84°50') (Environ. Can. 1977c; Goodier, pers. comm. 1979; Pycha, pers. comm. 1979). A minor run may have entered Alona Bay Creek (47°10', 84°42') (Goodier, pers. comm. 1979).

Whitefish Bay (46°40', 84°40'). Black trout spawned here October 10-25; spawning by redfin trout followed. River spawning has been reported in this area, and a minor run may have occurred in the Chippewa River (46°56', 84°27'). Spawning areas were identified as the bank (46°52', 84°34') off the west side of Batchawana Island (46°54', 84°30'), North (46°50', 84°40'), and South (46°48', 84°39') Sandy islands, Maple Island (46°46', 84°35'), along the adjacent mainland shoreline south to Goulais Point (46°41', 84°33'), Parisienne Shoal (46°45', 84°43'), especially the west side, the north point (46°43', 84°44') of Ile Parisienne (46°40', 84°43'), and along the shoreline from Kelly Creek (46°40', 84°29') to Gros Cap (46°32', 84°35'), where a fisherman observed lake trout cleaning spawning gravel in 6 ft of water (Environ. Can. 1977c; Goodier, pers. comm. 1979).

Spruce Harbor (location unknown). Spawn taking began on about September 15 (Ravenel 1898).

Pueblo River (location unknown). A spawn collection site (Ravenel 1898).

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SPLAKE

Splake (eastern brook trout x lake trout hybrid) were first stocked in the Great Lakes in Lake Huron in 1954 (OMNR 1973). No information was found concerning the introduction of splake into Lake Superior; presumably splake were planted in the lake during the late 1950s.

Minnesota

On November 21, 1957, splake eggs were collected from ripe fish along the Minnesota shore for incubation in hatcheries (Minn. DNR 1937-59).

Michigan

MS-4

In 1978, a "mature pair in ripe to spent condition" were collected October 4-November 14 in Presque Isle Harbor (46°34', 87°23'); they may have spawned on the rock and rubble covering the intake pipe of the Presque Isle Power Station (Peck 1979b).

RAINBOW SMELT

Rainbow smelt eggs planted in Crystal Lake (44°40', 86°10') (Lake Michigan drainage) in 1912, are believed to be the source of smelt found in all of the Great Lakes except Lake Ontario (Van Oosten 1937a). The first record of rainbow smelt in Lake Superior was established in Whitefish Bay (46°40', 84°50'), at the east end of the lake, in 1930 (Gollat 1976; USBCF 1969b; Van Oosten 1937a); these fish presumably entered the lake via the St. Marys River. In 1936, spawning runs were reported in tributaries at the east end of the lake (Van Oosten 1937a). After 1940, runs developed along the Ontario and Wisconsin shores (H. Johnson, pers. comm. 1979; Van Oosten 1953). During the 1950s, runs developed along the Minnesota shoreline (H. Johnson, pers. comm. 1979). Most tributaries receive major spawning runs in early April-early May (FWS 1979d). Runs into tributaries begin when the ice melts and peak in May. Some spawning may also occur on shoals and beaches where sufficient lake current exists (Eddy and Underhill 1974). In western Lake Superior, runs begin in the latter half of April and last about 3 weeks; spawning occurs over substrate varying from fine sand and rubble to coarse gravel (Fluegel 1978). Young smelt move out of tributaries soon after hatching (DeVore, pers. comm. 1979).

Minnesota

Spawning runs enter most streams along the North Shore (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979; USDI 1970). The runs do not progress beyond the first rapids; spawning also occurs in stream mouths and on sandy lake beaches at water temperatures of 33-58°F (Hale 1960). Runs usually occur late in April-early May (H. Johnson, pers. comm. 1979), and most of the catch is made at this time (USBCF 1969b). Since the 1950s, when the first runs appeared in the Duluth-Superior area, smelt have dispersed northward along the shore. The bulk of the run occurred in the French (46°54', 91°53') and Lester (46°50', 92°00') rivers during the mid-1960s and in the Grand Marais (47°45', 90°20') area during the 1970s (H. Johnson, pers. comm. 1979). Runs occur in the following areas along the Minnesota shore:

M-1

Stewart River (47°03', 91°38') (H. Johnson, pers. comm. 1979).

Silver Creek (47°04', 91°36') (Hale 1960).

Two Harbors (47°01', 91°40'). Smelt spawn along the beach in April to mid-May (FWS 1979d; Odin 1979). In 1977, spawning peaked on May 5 (Schaefer 1979).

Knife River (46°57', 91°47') (Adelman 1979). Spawners were present during March 15-April 15 (Jilek et al. 1979), and in early May (Schaefer 1979).

Big Sucker Creek (Sucker River) (46°55', 91°51') (H. Johnson, pers. comm. 1979).

French River (46°54', 91°53') (Adelman 1979; H. Johnson, pers. comm. 1979). Runs were first reported in 1946 (Hubbs and Lagler 1947). In 1953, the run occurred April 16-17 at a water temperature of 33°F; spawning substrate was rubble and boulders (Hale 1960).

Talmadge River (46°53', 91°55') (Adelman 1979).

Lester River (46°50', 92°00') (Adelman 1979; H. Johnson, pers. comm. 1979; Laundergan 1976). In 1953, eggs were collected on rocks on April 21 (Hale 1960). In 1977, spawning peaked on May 4 (Schaefer 1979).

St. Louis River (46°45', 92°06'). Extensive spawning occurs in the estuary and its tributaries from late April to early May at about 69°F (DeVore 1978; FWS 1979d; Minn. Power Light 1977; Schaefer 1979). Important areas in the estuary are the sandy beaches of the barrier island at the estuary mouth including Park Point at 46°44', 92°03', where spawning occurs in late April-early May (Hale 1960; Hassinger, pers. comm. 1979; Jilek et al. 1979; Pycha, pers. comm. 1979; Schaefer 1979). Heavy runs occur in the St. Louis River (Hale 1960; Hassinger, pers. comm. 1979;

DeVore et al. 1978; DeVore, pers. comm. 1979). Eggs and larvae were collected in St. Louis Bay (46°45', 92°07') (CDM/Limnetics 1976b; Siefert 1972). The estuary serves as an important nursery area (DeVore 1978; Schram, pers. comm. 1979). Larvae are extremely abundant during June and July (Anderson and Smith 1971). Smelt larvae were the second most abundant larvae in the lower St. Louis River in 1975; peak density occurred during early May to mid-June (Schaefer 1979).

M-2

Cascade River (47°42', 90°31') (Adelman 1979). In 1977, spawning peaked on May 6 (Schaefer 1979).

Poplar River (47°38', 90°42') (Adelman 1979).

Temperance River (47°33', 90°52'). In 1977, spawning peaked on May 6 (Schaefer 1979).

Taconite Harbor (47°32', 90°55'). At the Taconite Harbor Power Plant, smelt eggs were most abundant in mid to late May, peak impingement of adults occurred in May and June, and larvae were most abundant in the first half of July (Garmaker 1977).

Baptism River (47°20', 91°12') (Adelman 1979).

Beaver River (47°15', 91°18') (Adelman 1979; Schaefer 1979). Spawners were collected March 15-April 15 (Jilek et al. 1979), and in 1977, spawning peaked May 6 (Schaefer 1979).

Split Rock River (47°11', 91°24') (Adelman 1979).

M-3

Pigeon River (48°00, 89°34') and Grand Portage Bay (47°57', 89°40') (Hassinger, pers. comm. 1979).

Brule River (47°49', 90°03'), Kadunce Creek (47°48', 90°09'), Durfee Creek (47°47', 90°14'), and Devil Track River (47°46', 90°16'). (Adelman 1979).

Wisconsin

Smelt probably spawn in tributaries and on beaches along the entire shoreline (DeVore, pers. comm. 1979; King and Swenson, pers. comm. 1979; Schram, pers. comm. 1979). Runs begin when water temperatures reach approximately 40°F (Pycha, pers. comm. 1979; Schram, pers. comm. 1979). Spawning peaks on April 30 at Cornucopia (46°51', 91°06') and Herbster (46°50', 91°16') (Schaefer 1979). Runs occur in the following tributaries:

Superior Harbor (46°42', 92°01'). Heavy runs occur in the Nemadji River (46°42', 92°02') (DeVore et al. 1978; DeVore, pers. comm. 1979). Spawning also occurs on the sandy beaches of Wisconsin Point (46°42', 92°00') in late April-early May (Schaefer 1979). The harbor is an important nursery area; larvae drift downstream to the harbor after hatching (DeVore, pers. comm. 1979; De Vore et al. 1978; Schram, pers. comm. 1979). Young-of-the-year were found at the river mouth and at the harbor entrance (Schaefer 1979).

Amnicon River (46°41', 91°51'). Spawners were collected March 15-April 15 (Jilek et al. 1979), and in early May (Schaefer 1979). Very large numbers were collected in the FWS sea lamprey weir (FWS 1979c).

Middle River (46°42', 91°50'). Large numbers of spawners were collected in the FWS sea lamprey weir (FWS 1979c).

Brule River (46°45', 91°37'). Spawners were collected during March 15-April 15 (Jilek et al. 1979). Large runs begin and peak in early May (Bailey 1964; Pycha, pers. comm. 1979; Schaefer 1979; Schneider and Leach 1979). Approximately 426,000 adults were collected in the FWS sea lamprey weir in 1971 (FWS 1979c).

Iron River (46°46', 91°29'). Large numbers were collected in the FWS sea lamprey weir (FWS 1979c).

Chequamegon Bay (46°40', 90°50'). Chequamegon Bay is a major producer of smelt (Schneider and Leach 1979); large numbers run into shallow water to spawn along almost the entire shoreline (Kmiotek and Daly 1957; Sather and Threinen 1966). Spawning occurs on beach areas in the bay immediately before or after the ice moves out, in water as shallow as 2 ft (Pycha, pers. comm. 1979). In 1960, the on-shore run began April 21 (Bailey 1964). Spawning is reported to occur along most of the shoreline in Ashland Harbor (46°36', 90°53'), although success is probably reduced by the "littered" condition of the bottom (FWS 1979d). A run also enters Whittlesey Creek (46°36', 90°57'). Runs on the Apostle Islands (47°00', 90°40') shores are later than those in the bay (Pycha, pers. comm. 1979). Smelt larvae are found in the vicinity of the Apostle Islands at depths of less than 60 ft (Dryer 1966), first in late May, near the spawning beaches (Selgeby 1978).

Vandeventer (Washburn) Bay (46°39', 90°54'). Smelt eggs were collected from the bottom along the Washburn Bay beach area (Pratt and Swanson, pers. comm. 1979).

Bad River (46°38', 90°39'). Supports a large run (Schneider and Leach 1979).

Michigan

Runs last about 10 days and peak between April 19 and May 6 (Van Oosten 1953). Spawning occurs in the following areas:

MS-1

Isle Royale (48°00', 88°50'). In 1945, many young smelt were seined in late July around the mouth of the Big Siskiwit River (47°54', 89°00'), suggesting that a spawning run had become established in the river (Hubbs and Lagler 1947).

MS-2

Fire Steel River (46°56', 89°12') and Misery River (47°00', 88°59'). Many smelt were collected in the FWS sea lamprey weirs (FWS 1979c).

MS-3

Portage River (46°58', 88°26'). Spawning occurs at the entry to the river in April and May (Swedberg, pers. comm. 1979); runs also enter the Sturgeon River (47°02', 88°29') (Pycha, pers. comm. 1979).

Silver River (46°49', 88°17') and Huron River (46°55', 88°02'). Many were collected in the FWS sea lamprey weir (FWS 1979c).

MS-4

Dead River (46°34', 87°23'). Smelt move into Presque Isle Harbor (46°34', 87°23') in mid-April and are present until early June (Wapora 1976b). Runs enter the Dead River during late April-early May and spawning occurs at water temperatures of about 42°-47°F (Berg 1976; Swedberg, pers. comm. 1979; FWS 1979d; Wapora 1976b; Warner 1979). Larvae hatch in mid-May and then drift downstream to the harbor, where they spend the first 2 growing seasons before moving to the lake. Smelt eggs were observed just off the discharge canal of the Presque Isle Power Station in mid-April and near Picnic Rocks (46°33', 87°23') in early June (Wapora 1976b).

Chocolay River (46°30, 87°21'), Furnace Creek (46°26', 86°42'), and Anna River (46°25', 86°38') (Warner 1979).

MS-5

Sucker River (46°40', 85°56'). Smelt were collected in the FWS sea lamprey weir. Big Two Hearted River (46°42', 85°25'). Many were collected in the FWS sea lamprey weir (FWS 1979c).

Little Lake Harbor (46°43', 85°22'). Spawning occurs over cobble, rock, and gravel on the east side of the harbor. Carp River (46°44', 85°19'). Spawning occurs over gravel at the mouth of the river (Organ et al. 1978).

MS-6

Betsy River (46°41', 85°01'). Many smelt were collected in the FWS sea lamprey weir (FWS 1979c).

Naomikong Creek (46°29', 84°58'). A run occurs here, and probably in most creeks and on the sand beaches of Whitefish Bay (46°40', 84°50'), after ice breakup (Swedberg, pers. comm. 1979).

Ontario

OS-1

Current River (48°27', 89°11') and McVicar Creek (Vicar's Creek?) (48°26', 89°13'). Runs first occurred in 1941 (Dymond 1944).

OS-2

Black Bay (48°40', 88°30'). Spawning runs into tributaries were first seen in 1955 (Schneider and Leach 1979). Smelt are very abundant during the spawning season (Selgeby 1978).

OS-3

Cook Point (48°58', 88°14') and Five Mile Point (48°56', 88°14'). Smelt larvae were observed in the nearshore surface waters (Leslie and Kelso 1977).

OS-7

By 1941, runs were occurring in every small stream between Sault Ste. Marie (46°30', 84°21') and Cape Gargantua (47°36', 85°02') (Dymond 1944).

Goulais Bay (46°42', 84°30'). The first run here occurred in 1941 in Palmer Creek (location unknown). A run entered Kelly Creek (46°40', 84°29') in 1941 during mid-April to early May (Dymond 1944).

Batchawana Bay (46°51', 84°30'). Runs first occurred in tributaries to the bay in 1939. In 1941, a run entered Stokely Creek (46°49', 84°25') during mid-April to early May (Dymond 1944).

NORTHERN PIKE

Minnesota

M-1

St. Louis River (46°45', 92°06') and Duluth Harbor (46°45', 92°05'). The early literature reports what appear to have been spawning runs in the river. During 1875-80, a large seine and dip net fishery existed at Fond du Lac, 10 mi upstream from Duluth; the fishing was conducted for several weeks in spring when pike became very abundant. By 1885, the fishery had declined and thereafter was of little importance (Kaups 1978; Smith and Snell 1891). A population of northern pike resides and spawns in the St.

Louis River estuary and harbor area (DeVore 1978; Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979; Minn. Power Light 1977; Schram, pers. comm. 1979). Spawning occurs in April after the ice melts, in essentially all shallow, vegetated bays and backwaters and particularly in areas of flooded, emergent vegetation (DeVore 1978), including the shallows around dredge spoil islands in the outer harbor (FWS 1979d). The most important spawning and nursery areas are in the river upstream from the Arrowhead Bridge (46°43', 92°08') (DeVore 1978; Schram, pers. comm. 1979).

M-2

Gooseberry River (47°08', 91°27'). A population spawns in the estuary of the river (H. Johnson, pers. comm. 1979).

Wisconsin

Superior Harbor (46°42', 92°01'). Allouez Bay (46°41', 92°00') is one of the most important spawning and nursery areas in the harbor area (DeVore 1978, FWS 1979d; Schram, pers. comm. 1979).

Amnicon River (46°41', 91°51'), Middle River (46°42', 91°50'), and Brule River (46°45', 91°37'). A population resides and spawns in the mouths of these rivers (Schram, pers. comm. 1979).

Flag River (46°47', 91°23'). A population resides and spawns in the sloughs at the mouth of the river. Fish from the lake probably migrate up the Flag River about 1/4 mi to spawn in Bibon Lake (King, pers. comm. 1979; Schram, pers. comm. 1979; Swanson and Pratt, pers. comm. 1979).

Bark Bay (46°52', 91°10'). A population resides and spawns in the sloughs at the head of the bay (King, pers. comm. 1979; Schram, pers. comm. 1979).

Madeline Island (46°50', 90°40'). Spawning occurs in weedy areas along the shore of the island, including the back of Big Bay (46°49', 90°38'), the west side of the island (King, pers. comm. 1979), and Madeline Marina sloughs (46°46', 90°47', south of La Pointe) (Swanson and Pratt, pers. comm. 1979).

Chequamegon Bay (46°40', 90°50'). Northern pike move into and spawn in the Sioux River (46°44', 90°52') (King, pers. comm. 1979), the sloughs of Fish Creek (46°35', 90°57'), the Shortbridge Sloughs (46°35', 90°56') (Pycha, pers. comm. 1979; Swanson and Pratt, pers. comm. 1979), the Kakagon River (46°39', 90°45') (King, pers. comm. 1979; Pycha, pers. comm. 1979), the Washburn Mill Slips area (46°40', 90°54') (Swanson and Pratt, pers. comm. 1979) and possibly in the Sand Cut area at Oak Point (46°40', 90°43') (Pycha, pers. comm. 1979).

Bad River (46°38', 90°39'). Spawning occurs at the mouth of the river, and there is substantial movement of fish between the river and the lake (King, pers. comm. 1979).

Michigan

MS-3

Keweenaw Bay (46°58', 88°20'). Northern pike presently spawn over sand and bulrushes in late April to mid-May in Chassell (Pike) Bay (47°02', 88°30'). Spawning also occurs in May over vegetation in an area beginning 60-80 ft off Baraga (46°47', 88°29') (Organ et al. 1978).

MS-4

Presque Isle Harbor (46°34', 87°23'). Larvae are present in the harbor for a brief time in early June (Wapora 1976b), and spawning occurs in the Dead River (46°34', 87°23') (FWS 1979d; Odin 1979).

MS-6

Vermilion (46°46', 85°09'). Spawning probably occurred in the sedge marshes near Vermilion (Hankinson 1916).

Ontario

OS-3

Pays Plat River (48°53', 87°34'). A spawning run occurs in the river (SLCC 1979b).

MUSKELLUNGE

Minnesota

M-1

St. Louis River (46°45', 92°06'). Spawning occurs in the estuary (Hassinger, pers. comm. 1979).

Wisconsin

Superior Harbor (46°42', 92°01'). A native population spawns in the harbor (Schram, pers. comm. 1979).

Amnicon River (46°41', 91°51'). A resident population spawns in the mouth of the Amnicon River (Hassinger, pers. comm. 1979; Schram, pers. comm. 1979).

LAKE CHUB

The early literature reports that this species was probably common along the Canadian shore of the lake and in the coastal streams during the spawning season (Hubbs and Brown 1929).

CARP

Small populations of carp have been established for some time in shallow bays along both shores of Lake Superior (Lawrie and Rahrer 1973). Carp were planted in Lake Superior at Duluth in 1889, but this planting probably failed to establish a self-sustaining population in either the Duluth area or in Lake Superior proper. The source of the present population is unknown (McCrimmon 1968). Information on specific spawning sites was available only for U.S. waters.

Minnesota

M-1

St. Louis River (46°45', 92°06') and Duluth Harbor (46°45', 92°05'). A resident population spawns in the lower river and harbor in June (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979; Schram, pers. comm. 1979).

Wisconsin

Amnicon (46°41', 91°51'), Brule (46°45', 91°37'), Flag (46°47', 91°23'), and Siskiwit (46°51', 91°06') Rivers. Carp spawn in the mouths of these rivers (Schram, pers. comm. 1979; Swanson and King, pers. comm. 1979).

Bark Bay (46°52', 91°10'). Spawning occurs in the sloughs at the head of the bay (Schram, pers. comm. 1979).

Chequamegon Bay (46°40', 90°50'). Spawning occurs in the sloughs near the mouth of Fish Creek (46°35', 90°57') (Pycha, pers. comm. 1979), in the Shortbridge Sloughs (46°35', 90°56'), the sloughs in the Sioux River (46°44', 90°52'), and in the Kakagon River (46°39', 90°45') (Swanson and King, pers. comm. 1979).

Michigan

MS-4

Dead River (46°34', 87°23'). An observed increase in the abundance of ripe adults during July may have been caused by an influx of spawners from Lake Superior (Berg 1976).

EMERALD SHINER

Minnesota

Duluth Harbor (46°45', 92°05'). Emerald shiners spawn along the lake side of the sandy barrier island (46°44', 92°03) separating the lake and the harbor (Hassinger, pers. comm. 1979).

Wisconsin

M-1

Superior Harbor (46°42', 92°01'). Adults have been collected during spawning runs from the lake into Superior Harbor (Schram, pers. comm. 1979). At the Winslow Power Plant in Superior (46°44', 92°05'), emerald shiners impinged in June and July possessed mature gonads, whereas most of those impinged in August were spent (CDM/Limnetics 1976). Fry were also collected in the area (CDM/Limnetics 1976b; Siefert 1972).

SPOTTAIL SHINER

Wisconsin

Superior Harbor (46°42', 92°01'). A run, possibly a spawning run, enters the harbor from the lake (Schram, pers. comm. 1979).

Ontario

OS-7

Sable River (46°57', 84°35'), Harmony River (46°51', 84°23'), and Stokely Creek (46°49', 84°25'). In 1954, hundreds of ripe spottail shiners were taken at the mouths of these tributaries on June 11-20; these were assumed to be spawning aggregations (Scott and Crossman 1973).

LONGNOSE DACE

Michigan

MS-1

Isle Royale (48°00', 88°50'). Young were captured at the mouth of the Little Siskiwit River (47°56', 88°57'), and a male in breeding color was observed here in mid-July (Hubbs and Lagler 1947).

LONGNOSE SUCKER

Each spring, large numbers of longnose suckers enter Lake Superior tributaries to spawn (Dryer 1966). The spawning runs generally occur at the same time as those of the sea lamprey (Erkkila et al. 1956).

Minnesota

Runs occur in every tributary on the Minnesota North Shore in late May, just after the major part of the steelhead run (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979). Large runs were also observed on about July 1 (Jordan 1885). Fingerlings also are common in the mouths of most North Shore streams (Smith and Moyle 1944). Spawning runs have been reported specifically in the following areas:

M-1

Big Sucker Creek (Sucker River) (46°55', 91°51'), French River (46°54', 91°53'), and Lester River (46°50', 92°00'). Major run (H. Johnson, pers. comm. 1979).

St. Louis River (46°45, 92°06'). Large runs enter the harbor and migrate up the St. Louis River (46°45', 92°06'), and the smaller tributaries of the estuary; there are also runs to the natural and man-made gravel shoals in the estuary (DeVore 1978; DeVore et al. 1978; FWS 1979d; Hassinger, pers. comm. 1979). Longnose suckers spawn in the same riffle areas as the walleye (DeVore 1978), below the dam at Fond du Lac (46°40', 92°16') (Minn. Power Light 1977). After spawning, the adults return to Lake Superior (DeVore 1978). The newly hatched larvae, which are concentrated at the surface, drift downstream from the tributaries into the estuary and Lake Superior (DeVore et al. 1978). Fry have been seined in shallow areas of the estuary (CDM/Limnetics 1976b).

Wisconsin

Runs probably occur in most warm-water streams along the Wisconsin shore (King, pers. comm. 1979).

Nemadji River (46°42', 92°02'). Supports a large run (DeVore 1978; DeVore et al. 1978; Schram, pers. comm. 1979). Newly hatched larvae drift downstream to Superior Harbor (46°42', 92°01') (DeVore et al. 1978).

Amnicon River (46°41', 91°51'). Supports a spawning run (Schram, pers. comm. 1979).

Poplar River (46°42', 91°47'). May support a spawning run (Pycha, pers. comm. 1979).

Brule River (46°45', 91°37'). The river supports a spawning run (Bailey 1969; Pycha, pers. comm. 1979), which usually reaches a peak sometime in mid-April to late May, when the water temperature rises to about 55°F. If the temperature drops during the run, a second run sometimes occurs when the temperature again increases. Water temperatures above 60°F cause the run to decline sharply (Bailey 1969). No young-of-the-year (YOY) were found at the mouths of the Brule or adjacent streams; the larvae probably drift out into the lake soon after hatching (Bailey 1969).

Apostle Islands (47°00', 90°40'). Longnose suckers spawn along shore among the islands (King, pers. comm. 1979). The inshore movement is reflected in reduced catches farther offshore in the lake during spring and early summer (Dryer 1966).

Sioux River (46°44', 90°52'). A large run occurs here after the rainbow trout run (Swedberg, pers. comm. 1979).

Bad River (46°38', 90°39'). Many longnose suckers were captured in the FWS sea lamprey weir in April-July (Dahl and McDonald 1980).

Michigan

MS-1

Isle Royale (48°00', 88°50'). Longnose suckers move from the shoreline areas into streams to spawn. A running-ripe male was collected in late July. Young are most common around the shoreline (Hubbs and Lagler 1947).

MS-3

Pine River (46°53', 87°52'). A spawning run occurred here (Hubbs 1929).

MS-4

Dead River (46°34', 87°23'). The river supports a spawning run (Wapora 1976a,b). In 1975, males in breeding colors were found in the river on May 6, and spawning occurred in the river from the second week of April into early May, at water temperatures of about 36-43°F. Large numbers of adults remained in Presque Isle Harbor (46°34', 87°23') through summer and fall. No larvae or YOY were found in the harbor during the summer, but spawning was probably successful (Berg 1976; Wapora 1976b).

MS-6

Pendills Creek (46°27', 84°49'). A run begins in late April and is heaviest in May (Gleason and Behmer, pers. comm. 1979).

Ontario

OS-3

Nipigon River (48°57', 88°15'). Until 1964, when kraft mill pollution evidently stopped the run, longnose suckers spawned in the lower river at the town of Nipigon (49°01', 88°16') on the same grounds used by walleye. The longnose sucker was still common in Nipigon Bay (48°53', 87°50') in 1968, and other spawning areas must have been in use (Ryder 1968).

OS-7

Pancake River (46°58', 84°40'). Supports a very heavy run in April-June, which reaches a peak in May. Batchawana River (46°56', 84°32'). Supports a run in May (Price 1955).

WHITE SUCKER

White suckers are found in tributary streams throughout the year, but large numbers also migrate from Lake Superior into streams to spawn (Moore and Braem 1965). All warm-water streams in Wisconsin probably have runs (King, pers. comm. 1979). The white sucker and sea lamprey spawning runs occur at the same time in Lake Superior tributaries (Erkkila et al. 1956). In U.S. waters, runs have been reported for the following areas:

Minnesota

M-1

Big Sucker Creek (Sucker River) (46°55', 91°51'). Run occurs in late May. Lester River (46°50', 92°00'). Run occurs in May (H. Johnson, pers. comm. 1979).

St. Louis River (46°45', 92°06'). Spawning runs occur in the river and other smaller tributaries of the estuary; concentrations of spawners are also found on the natural and man-made gravel shoals in the estuary (DeVore 1978; DeVore et al. 1978; FWS 1979d; Hassinger, pers. comm. 1979). Newly hatched larvae drift downstream to the lake (DeVore et al. 1978). Fry have been collected in the lower river, mainly during early June to mid-August (Minn. Power Light 1977).

Wisconsin

Nemadji River (46°42', 92°02'). Supports a spawning run (DeVore 1978; DeVore et al. 1978; Schram, pers. comm. 1979). Newly hatched larvae drift downstream to Superior Harbor (46°42', 92°01') (DeVore et al. 1978).

Amnicon River (46°41', 91°51'). A run occurs in the river (Schram, pers. comm. 1979).

Brule River (46°45', 91°37'). A run occurs in the river (Schram, pers. comm. 1979). Many white suckers have been captured at the FWS sea lamprey weir in April-July (Dahl and McDonald 1980). Young-of-the-year have been found in the mouth of the river during July and August (Bailey 1969).

Apostle Islands (47°00', 90°40'). White suckers have spawned along shore among the islands (King, pers. comm. 1979).

Bad River (46°38', 90°39'). Many white suckers were captured at the FWS sea lamprey weir in April-July 1956 (Dahl and McDonald 1980).

Michigan

MS-4

Dead River (46°34', 87°23'). A run enters the river and spawning usually begins about the second week of May, when the water temperature reaches 50°F. Ripe adults have been collected in the river in late April and mid-May. Larvae drift downstream into Presque Isle Harbor (46°34', 87°23'). In 1975, larvae were found at the river mouth on June 2-24 and in the harbor throughout the summer. The discharge area of the Presque Isle Power Station, close to the river mouth, is a nursery area (Berg 1976; Wapora 1976a,b).

MS-6

Pendills Creek (46°27', 84°49'). The run begins in late April and is heaviest in May (Gleason and Behmer, pers. comm. 1979).

Ontario

OS-3

Nipigon River (48°57', 88°15'). Until 1964, when kraft mill pollution evidently stopped the run, white suckers spawned in the lower river at the town of Nipigon (49°01', 88°16') on the same grounds used by walleye. The white sucker was still common in Nipigon Bay (48°53', 87°50') in 1968, and other spawning areas must have been in use (Ryder 1968).

OS-7

Heavy runs occur in April-June in the eastern end of the lake in the Pancake River (46°58', 84°40'), Sable River (46°57', 84°35'), Batchawana River (46°56', 84°32'), Chippewa (Harmony) River (46°56', 84°27'), Harmony (Creek) River (46°51', 84°23'), Stokely Creek (46°49', 84°25'), Goulais River (46°43', 84°27'), and Cranberry Creek (46°42', 84°25') (Price 1955).

SUCKER spp.

Suckers of all species probably run into all of the streams along the south shore of Lake Superior (DeVore, pers. comm. 1979).

Minnesota

M-1

Duluth Harbor (46°45', 92°05'). Spawning occurs in the tributaries to the harbor, and larvae are found in shallow areas of the harbor in rather high densities (DeVore 1978; Schram, pers. comm. 1979). Larvae present in the harbor probably include those of the four species (white suckers, longnose suckers, silver redhorse, shorthead redhorse) that spawn in the harbor tributaries (DeVore 1978).

Wisconsin

Superior Harbor (46°42', 92°01'). Sucker fry were found in the harbor (Schram, pers. comm. 1979); they were found earliest at Barkers Island (46°43', 92°03'), and spawning probably occurs there (DeVore 1978).

Michigan

MS-3

Falls River (46°45', 88°27'). A dipnet fishery for suckers was conducted in the spring at the mouth of the river (Smith and Snell 1891).

Ontario

OS-3

Pays Plat River (48°53', 87°34'). Supports a spawning run (SLCC 1979b).

SILVER REDHORSE

Minnesota

M-1

St. Louis River (46°45', 92°06'). Adults migrate to the tributaries and the natural and man-made gravel shoals in the estuary to spawn; the newly hatched larvae drift downstream from the tributaries to the estuary (DeVore 1978; DeVore et al. 1978; FWS 1979d; Hassinger, pers. comm. 1979). Adults may remain in the harbor through the summer (DeVore 1978; Schram, pers. comm. 1979). Newly hatched larvae drift downstream to Superior Harbor (46°42', 92°01') (DeVore et al. 1978).

Wisconsin

Nemadji River (46°42', 92°02'). Spawning runs occur (DeVore 1978; DeVore et al. 1978).

SHORTHEAD REDHORSE

Minnesota

M-1

St. Louis River (46°45', 92°06'). Adults migrate to the tributaries and the natural and man-made gravel shoals in the estuary to spawn; newly hatched larvae drift downstream to the estuary (DeVore 1978; DeVore et al. 1978; Hassinger, pers. comm. 1979). Adults may remain in the estuary through the summer (DeVore 1978).

Wisconsin

Nemadji River (46°42', 92°02'). Spawning runs occur (DeVore 1978; DeVore et al. 1978; Schram, pers. comm. 1979). Newly hatched larvae drift downstream to Superior Harbor (46°42', 92°01') (DeVore et al. 1978).

REDHORSE spp.

Ontario

OS-7

Heavy runs of an unidentified species of redhorse have been reported in three Ontario tributaries (Price 1955): Batchawana River (46°56', 84°32'), Chippewa (Harmony) River (46°56', 84°27'), and Goulais River (46°43', 84°27').

BLACK BULLHEAD

Minnesota

M-1

St. Louis River (46°45', 92°06'). A large resident population spawns in the estuary (Hassinger, pers. comm. 1979; Schram, pers. comm. 1979). Small numbers of young were collected in the lower river, from mid-July to late August, and spawning was assumed to occur throughout the lower river and estuary in areas where there was firm bottom and cover (Minn. Power Light 1977).

Wisconsin

Superior Harbor (46°42', 92°01'). Spawning occurs in Allouez Bay (46°41', 92°00') (Schram, pers. comm. 1979).

TADPOLE MADTOM

Wisconsin

Superior Harbor (46°42', 92°01'). A resident population spawns in Superior Harbor and Allouez Bay (46°41', 92°00') (Schram, pers. comm. 1979).

TROUT-PERCH

During July and August, trout-perch move from depths of more than 210 ft into very shallow areas of the lake or into tributary streams to spawn. A return migration to deeper water occurs by late September and early October (Bostock 1967).

Minnesota

M-1

Duluth Harbor (46°45', 92°05'). Spawning also occurs on the east side of the barrier island separating the harbor from the lake (Hassinger, pers. comm. 1979).

Wisconsin

Superior Harbor (46°42', 92°01'). A resident population spawns in the harbor (Schram, pers. comm. 1979), and fry have been collected there (CDM/Limnetics 1976b).

Michigan

MS-3

Keweenaw Bay (46°58', 88°20'). Three young-of-the-year were collected here in early September (Bostock 1967).

BURBOT

Minnesota

M-1

Knife River (46°57', 91°47'). A spawning run occurs here and young-of-the-year (YOY) have been observed (H. Johnson, pers. comm. 1979).

M-3

Pigeon River (48°00', 89°34'). A spawning run may occur here (H. Johnson, pers. comm. 1979).

Wisconsin

Nemadji River (46°42', 92°02). A spawning run enters Superior Harbor and the river in early November and peaks in mid-winter (DeVore 1978; DeVore et al. 1978; FWS 1979d; Schram, pers. comm. 1979; Swanson, King, and Pratte, pers. comm. 1979). The adults remain in the harbor until about mid-June, when they return to the lake. Tagging studies showed some post-spawning movement of adults out of the Superior Harbor along shore to the Brule River (46°45', 91°37') (Schram, pers. comm. 1979).

Amnicon River (46°41', 91°51'). A spawning run occurs here (DeVore, pers. comm. 1979; Schram, pers. comm. 1979).

Apostle Islands (47°00', 90°40')--Chequamegon Bay (46°40', 90°50'). Spawning in this area generally occurs in December and January. Spawning occurs off Washburn (46°40', 90°54') and may also occur about 3 mi E of Outer Island (47°02', 90°26') (Swanson, King, and Pratte, pers. comm. 1979), where numerous juveniles are found in the spring (Coberly and Horrall 1980b). The collection of ripe and spent adults in 1968 indicated a prolonged spawning season, a migration to inshore spawning areas, or differences in spawning dates between the Apostle Islands and locations to the south. Most adults collected near shore south of Bayfield (46°49', 90°49') had spawned by February 26 and all were spent by March 11. In the Apostle Islands, recently spent burbot were first seen in early to mid-May (Bailey 1972).

Bad River (46°38', 90°39'). A spawning run occurs here (DeVore, pers. comm. 1979; Swanson, King, and Pratte, pers. comm. 1979).

Michigan

MS-3

Keweenaw Bay (46°58', 88°20'). Spawning occurs in November in the middle of the bay at depths of 360-480 ft and at the mouth of the Portage River (46°58', 88°26'), over mud, sand, and gravel. Runs peak in the Sturgeon River (47°02', 88°29') under ice in late December and early January; spawning is reported in the river as early as November over mud, sand, and gravel (Organ et al. 1978).

MS-4

Presque Isle Harbor (46°34', 87°23'). An influx into the harbor from the lake is suggested by the increased catch of adults, including gravid females, in October (Wapora 1976b). Spawning occurs throughout the harbor in January-March (Wapora 1976a). Larvae are found throughout the harbor in June-August (Wapora 1976a,b), and larger YOY are collected there in August-October (Berg 1976). Spawning also probably occurs in the lower Dead River (46°34', 87°23'). Spent females, probably returning to the lake, were captured in the Dead River in late October and November (Berg 1976).

Ontario

OS-7

Ile Parisienne (46°40', 84°43'). Burbot spawn on clay banks along the west side of Ile Parisienne in Whitefish Bay (Goodier, pers. comm. 1979).

BROOK SILVERSIDE

Michigan

MS-4

Dead River (46°34', 87°23'). This species is rare in Lake Superior and was first collected June 4, 1974, in the lower Dead River. Two of the three fish collected were gravid adults (Berg et al. 1975).

NINESPINE STICKLEBACK

Large catches of this species are occasionally made at depths of 18-30 ft during the inshore spawning migration in June and July (Tait 1973). The species is common or abundant along the entire south shore of the lake (Pycha, pers. comm. 1980).

Wisconsin

Apostle Islands (47°00', 90°40'). Spawning occurs throughout this area during June and July after an inshore movement to shoal areas (Griswold 1970; Griswold and Smith 1973; Pycha, pers. comm. 1979). At this time, adults are found over sand and rubble along the west shore of Madeline Island (49°50', 90°40') at depths of less than 35 ft (Pycha, pers. comm. 1979). On the south side of Oak Island (46°56', 90°44'), ripe males and females in breeding colors were found in a dense growth of Nitella and were assumed to be spawning. Ripe adults were also found at 72-144 ft on the south side of Stockton Island (46°56', 90°35') over a substrate of organic mud and were assumed to be spawning (Griswold 1970; Griswold and Smith 1973).

Michigan

MS-4

Presque Isle Harbor (46°34', 87°23'). Successful reproduction occurred in 1975-76. Adults moved into the harbor in late May-early June, larvae were entrained at the Presque Isle Power Station, and larger young-of-the-year were subsequently collected. The spawning site is unknown because no nests were found; if a weedy area is required, the only one in the harbor is off the ore dock in the northern portion of the harbor (Wapora 1976b).

WHITE BASS

Michigan

MS-4

Presque Isle Harbor (46°34', 87°23'). This species is rare in Lake Superior. On August 18, 1975, one young-of-the-year white bass was collected in a sandy area about 2-3 ft deep in the northern part of Presque Isle Harbor (Hatch and Clark 1975).

ROCK BASS

Minnesota

M-1

St. Louis River (46°45', 92°06'). The estuary has a resident population (Hassinger, pers. comm. 1979).

SMALLMOUTH BASS

Minnesota

M-1

St. Louis River (46°45', 92°06'). The estuary contains a resident population (Hassinger, pers. comm. 1979).

Wisconsin

Bark River (46°51', 91°11'). Extensive spawning grounds existed at the mouth of the river, and numerous fry were seen there (Van Oosten 1938b).

Ashland (46°36', 90°53'). Spawning occurs at the head of Chequamegon Bay (46°40', 90°50') at the old docks adjacent to the Ashland Power Plant (Pratte, pers. comm. 1979).

Sand Cut (46°40', 90°43'). Spawning occurs in the Sand Cut area. Bad River (46°38', 90°39'). A population exists at the mouth of the Bad River, and extensive movement occurs between the lake and the river; spawning occurs in both the Bad and the White Rivers (King and Swanson, pers. comm. 1979).

Michigan

MS-4

Presque Isle Harbor (46°34', 87°23'). In 1975, divers observed a few adults in late June over gravel bottom at the intake of the Presque Isle Power Station; depressions in the gravel that may have been spawning beds were seen, but no eggs were observed. Two young-of-the-year (YOY) or yearlings were found at the plant's forebay in November (Wapora 1976b). Spawning may be occurring in the harbor but is not confirmed. Smallmouth may migrate into the Dead River (46°34', 87°23'); YOY were seen in the river during June-September (Berg 1976).

BLACK CRAPPIE

Minnesota

M-1

St. Louis River (46°45', 92°06'). The estuary contains a resident population (Hassinger, pers. comm. 1979).

JOHNNY DARTER

Wisconsin

Superior Harbor (46°42', 92°01'). A resident population spawns in the harbor (Schram, pers. comm. 1979).

YELLOW PERCH

Minnesota

M-1

French River (46°54', 91°53'). Young-of-the-year (YOY) were found at the mouth of the river in early July 1976 or 1977. This is the only known occurrence of yellow perch here (H. Johnson, pers. comm. 1979).

St. Louis River (46°45', 92°06'). The estuary and Duluth Harbor (46°45', 92°05') are spawning and nursery areas; yellow perch rarely move from the estuary into the lake (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979; Schram, pers. comm. 1979). Spawning occurs from mid-April to mid-May in many shallow areas, where the substrate is sand, muck, silt, rip-rap, submerged vegetation, or brush (DeVore 1978; Schram, pers. comm. 1979). The distribution of fry indicates that the most extensive spawning takes place upstream in the backwaters and bays of the St. Louis River estuary (DeVore 1978). The estuary and the harbor are important nursery areas; YOY are found here in stands of weeds (DeVore 1978; H. Johnson, pers. comm. 1979; Schram, pers. comm. 1979). Yellow perch fry are more abundant than fry of other species in the lower river (Minn. Power Light 1977).

M-3

Pigeon Bay (48°01', 89°31'). The western shore at the head of the bay is a spawning and nursery area (Hassinger, pers. comm. 1979).

Wisconsin

Superior Harbor (46°42', 92°01'). Allouez Bay (46°41', 92°00'), the area around dredge spoil islands in the outer harbor, the sand bar at the harbor entrance, and Barker's Island (46°43', 92°03') are spawning areas (DeVore 1978; FWS 1979d; H. Johnson, pers. comm. 1979; Schram, pers. comm. 1979). In 1975, both mature and spent adults were found in the estuary April 3 to May 24 (CDM/Limnetics 1976b). In 1975, larvae were abundant in June and July and reached maximum density on June 17 (CDM/Limnetics 1976b).

Port Wing (46°47', 91°23') and Bark Bay (46°52', 91°10'). Spawning occurs here (Swanson, King, and Pratte, pers. comm. 1979).

Chequamegon Bay (46°40', 90°50'). Yellow perch spawn in shallow, weedy areas of the bay (Swanson, King, and Pratte, pers. comm. 1979) and the shallows to depths of 10-12 ft are nursery areas, especially along the east shore (Pycha, pers. comm. 1979). Spawning occurs off Washburn (46°40', 90°54'), at the pilings near the old docks by the Ashland Power Plant, around Oak Point (46°40', 90°46'), at the Sand Cut (46°40', 90°43') (Pycha, pers. comm. 1979; Sather and Threinen 1966; Swanson, King, and Pratte, pers. comm. 1979), and in areas south of Bayfield (46°49', 90°49') (Coberly and Horrall 1980b).

Michigan

MS-3

Keweenaw Bay (46°58', 88°20'). Yellow perch spawn in June over vegetation off Baraga (46°47', 88°29'), south of Sand Point (46°47', 88°28'). Since 1929, spawning also occurred in June over sand in Pequaming Bay (46°50', 88°24') (Organ et al. 1978).

MS-4

Big Garlic River (46°43', 87°34'). In 1967, yellow perch by-passed barriers in the river during a flood and spawned in April and May. Adults and YOY moved downstream in fall (Manion 1977).

Presque Isle Harbor (46°34', 87°23'). Ripe adults are present by May. In 1975, collections of larvae showed that spawning occurred in the harbor and also in the Dead River (46°34', 87°23'). Larvae first appeared in mid-May and were found throughout the harbor; the major nursery area may be the northwest section of the harbor near the discharge of the Presque Isle Power Station. Larvae are numerous by July. Young-of-the-year yellow perch remained here during the summer, and large schools were often seen by divers (Berg 1976; Wapora 1976b).

MS-6

Tahquamenon Bay (46°30', 85°00'). Spawning occurs during the spring and early summer at depths of about 9-13 ft over rock and vegetation off the mouth of Galloway Creek (46°32', 85°03') (Organ et al. 1978). A large run entered the Tahquamenon River (46°33', 85°02') (Stauffer and Hansen 1958); this may have been a spawning run.

Ontario

OS-2

Black Bay (48°40', 88°30'). Spawning occurs at the head of the bay (Gollat 1976).

WALLEYE

Minnesota

M-1

St. Louis River (46°45', 92°06'). Spawning runs enter the river from Lake Superior, and the estuary of this river is perhaps the prime spawning area in the entire western end of Lake Superior (DeVore 1978; Schram, pers. comm. 1979). Before the arrival of the white man, the Ojibway Indians at Fond du Lac fished the spawning runs on the rapids for about 3 weeks in April (Kaups 1978). The large riffle area above Hwy. 23 Bridge at Fond du Lac is the major spawning area in the river and perhaps in the entire western part of Lake Superior (DeVore 1978). Despite problems with water quality, runs have persisted (Schneider and Leach 1979). The run into the estuary begins under the ice in late February or early March and peaks when the ice breaks up. Spawning occurs during mid-April to early May over sand, rock and rubble substrate (DeVore 1978; Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979; Schram, pers. comm. 1979). In 1977, many ripe adults were found on riffles in the estuary on April 28, and the first spent fish was found on May 2; no adult walleyes were found after May 6 (DeVore 1978). Adults may remain in the harbor area for 2-3 months, but most return to the lake by mid-July (FWS 1979d). After entering the lake, the adults move along the south shore at least as far as the Apostle Islands (47°00', 90°40'); by February they have returned to the St. Louis River estuary area (DeVore, pers. comm. 1979; H. Johnson, pers. comm. 1979; Schram, pers. comm. 1979). The lower estuary and Duluth Harbor (46°45', 92°05') are important walleye nursery areas (Hassinger, pers. comm. 1979; Schram, pers. comm. 1979). Walleye fry were the third most abundant fry collected in the lower river; abundance was highest during mid-May to early August (Minn. Power Light 1977). In 1977, fry were first seined on June 14 (DeVore 1978). Some young-of-the-year (YOY) remain in the harbor while others move out into the lake (Schram, pers. comm. 1979). Fingerlings are often found in fair numbers in the lake (DeVore 1978).

M-3

Pigeon River (48°00', 89°34'). Substantial spawning runs occur here, and the western end of Pigeon Bay is a nursery area (Hassinger, pers. comm. 1979; H. Johnson, pers. comm. 1979).

Wisconsin

Pokegama River (46°41', 92°10')--Allovez Bay (46°41', 92°00'). A run also occurs in the Pokegama River, a tributary to the lower St. Louis River (46°45', 92°06') (DeVore 1978; DeVore et al. 1978), and spawning occurs in the Pokegama Bay (46°42', 92°10') area (Minn. Power Light 1977). Almost immediately after spawning, adults move downstream; areas of concentration during the downstream movement include Allouez Bay (46°41', 92°00') and the Nemadji River (46°42', 92°02') (DeVore 1978). Good nursery habitat is provided by the inlets and shoreline areas below Pokegama Bay (DeVore 1978). In 1975, larvae first appeared in the cooling water of the Winslow Power Plant (46°44', 92°05') in late May and reached maximum density on June 9 (CDM/Limnetics 1976b). Superior Harbor (46°42', 92°01') is an important nursery area (Hassinger, pers. comm. 1979; Schram, pers. comm. 1979).

Amnicon River (46°41', 91°51'). A small spawning run occurs here just after ice-out in late April to early May (DeVore 1978, pers. comm. 1979; King, pers. comm. 1979; Schram, pers. comm. 1979). By late August, YOY are found at the mouth of the river (Schram, pers. comm. 1979).

Kakagon River (46°39', 90°45')--Chequamegon Bay (46°40', 90°50'). A distinct population of walleyes runs up the Kakagon River into the Kakagon sloughs beginning in late February and spawns in April-early May (Daly 1954; King, pers. comm. 1979; Kmiotek and Daly 1957; Pycha, pers. comm. 1979; Schram, pers. comm. 1979; Swedberg and Selgeby 1979). After spawning, the adults leave the sloughs and return to the bay (Pycha, pers. comm. 1979). The return migration can begin as early as late May, and most have left the river by August (Daly 1954). There is little movement between Chequamegon Bay and the lake proper (Swedberg and Selgeby 1979). Young-of-the-year have been collected in the bay; areas along the east shore at depths to 10-12 ft are nursery grounds (Swedberg, pers. comm. 1979).

Bad River (46°38', 90°39'). A spawning run enters the river and a tributary, the White River, (King, pers. comm. 1979; Pycha, pers. comm. 1979). After spawning, the adults return to Lake Superior and move along the shore to Long Island (46°43', 90°46') and Marble Point (46°35', 90°30') (Swedberg, pers. comm. 1979).

Michigan

MS-2

Ontonagon River (46°52', 89°20'). A large spawning run entered the lower river (Stauffer and Hansen 1958).

MS-3

Keweenaw Peninsula (47°10', 88°30'). Spawning probably occurred in area rivers. By the 1940s, catches in the area had declined to almost nothing (Schneider and Leach 1979).

Sturgeon River (47°02', 88°29'). A run enters the river from Lake Superior in the spring (Stauffer and Hansen 1958).

Huron Bay (46°55', 88°10'). Spawning probably occurred in area rivers (Schneider and Leach 1979).

MS-4

Little Iron River (46°49', 87°39'). On May 2, 1948, viable walleye eggs were collected below a dam at the outlet of Lake Independence, 2-3 mi upstream from Lake Superior (Eschmeyer 1950).

MS-6

Whitefish Bay (46°40', 84°50'). The bay supported one of the largest populations of walleye, and spawning probably occurred in area rivers. Catches declined to almost nothing by the 1940s (Schneider and Leach 1979).

Ontario

OS-1

Thunder Bay (48°25', 89°00'). The bay supports a minor population (Schneider and Leach 1979), but no spawning sites have been documented.

OS-2

Black Bay (48°40', 88°30'). During 1948-75, 84% of the Ontario walleye harvest came from Black Bay. Spawning occurred on the shoals at the north end of the bay. A small spawning run also entered the Black Sturgeon River (48°50', 88°24'). The harvest declined rapidly in the mid 1960s and was almost nonexistent in 1972 (Ryder 1968; Schneider and Leach 1979).

OS-3

Nipigon River (48°57', 88°15'). Nipigon Bay (48°53', 87°50') supported a large population, and a spawning run entered the lower river (Ryder 1968). Adults first appeared in late April and spawned in early May near the town of Nipigon (49°01', 88°16'). This is the only known spawning area in the Nipigon watershed; areas of large pebbles and boulders out of the main channel or in a back eddy are the preferred spawning substrate. By June, the adults dispersed upstream to Polly Lake 9 mi from the tagging site and downstream to Nipigon Bay (48°54', 87°50).

Between 1958 and 1966, the walleye runs were nearly extinguished, apparently as a result of pollution from kraft mills (Ryder 1957, 1968; Schneider and Leach 1979).

Jackfish River (49°00', 88°05'). This was a very important walleye stream in the 1950s; many spawners were found at the CDFO sea lamprey barriers (Speirs 1955).

Pays Plat River (48°53', 87°34'). Supports a spawning run of "pickerel" (SLCC 1979b).

OS-7

Agawa Bay (47°21', 84°39') and Batchawana Bay (46°51', 84°30'). Each supports a minor population (Schneider and Leach 1979), but no spawning sites have been documented.

Goulais Bay (46°42', 84°30'). Supports a minor population (Schneider and Leach 1979). Walleye spawn in the Goulais River (46°43', 84°27') at the Goulais Rapids (46°45', 84°16') (Environ. Can. 1977c).

MOTTLED SCULPIN

Michigan

MS-4

Presque Isle Harbor (46°34', 87°23'). Spawning occurs in May, probably on rocks covering the intake and discharge structures of the Presque Isle Power Station or under submerged logs. Ripe females were collected in May, larvae in mid-June to mid-July, and young-of-the-year in late summer and fall (Wapora 1976a,b).

SLIMY SCULPIN

This species is common throughout the lake and probably spawns in many places along the shore (Pycha, pers. comm. 1979).

Michigan

MS-4

Presque Isle Harbor (46°34', 87°23'). The slimy sculpin is believed to spawn on the large rocks covering the water intake and discharge system of the Presque Isle Power Station. Ripe females were found in April, larvae in mid-June to mid-July, and young-of-the-year in late summer and fall (Wapora 1976b).

MS-6

Whitefish Point (46°46', 84°57'). Ripe adults were collected here over sand bottom (Nourse, pers. comm. 1979).

SPOONHEAD SCULPIN

Michigan

MS-4

Presque Isle Harbor (46°34', 87°23'). Adults were not common in the harbor, but spawning occurred in or near the harbor, probably in rocky areas or under logs. Larvae were present in the harbor in April-June and were fairly abundant in the discharge plume area of the Presque Isle Power Station (46°34', 87°24') (Wapora 1976a,b).

FOURHORN SCULPIN

All collections of fourhorn sculpins made in southern Lake Superior in May through August 1952 contained a few ripe or nearly ripe females. Individuals 20 mm long were found at depths of 60-714 ft; most small fish, with an average length of 29 mm, were found at depths of 60-174 ft (Jacoby 1953).

Wisconsin

Stockton Island (46°56', 90°35'). Spawning occurs primarily in mid-winter but could extend from late November to mid-May. In 1974, two ripe females were found here in mid-May at a depth of 690 ft. Young-of-the-year were captured in fall, but summer nursery areas were not located (Selgeby 1979).

Michigan

MS-4

Presque Isle Harbor (46°34', 87°23'). Spawning apparently occurred in or near the harbor in fall, because sculpin larvae, some of which were identified as fourhorn sculpin larvae, were collected throughout the harbor in the winter and early spring. Large numbers of sculpin larvae were also entrained at the Presque Isle Power Station from mid-December to May; these larvae were not subjected to rigorous taxonomic scrutiny but appeared to be of the same species as the larvae collected in the harbor in winter and early spring. A clump of eggs believed to be sculpin eggs was found at the power plant intake near growths of Chara in mid-December 1975 (Wapora 1976b).

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This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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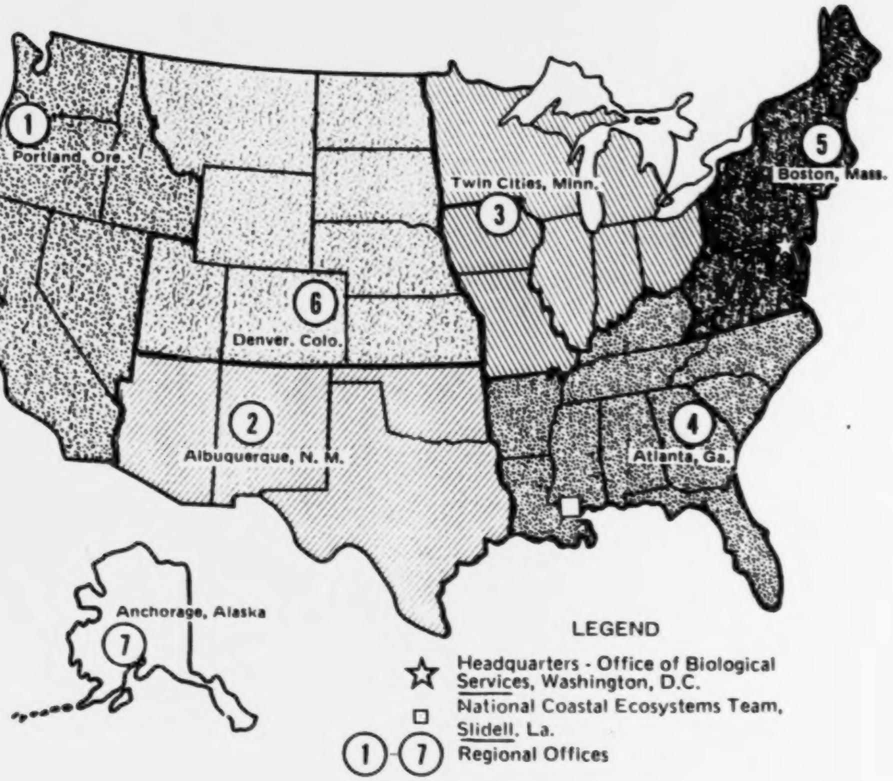
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Biological Services Program

FWS/OBS-82/52
SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES
Volume III-St. Mary's River

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME III
St. Mary's River

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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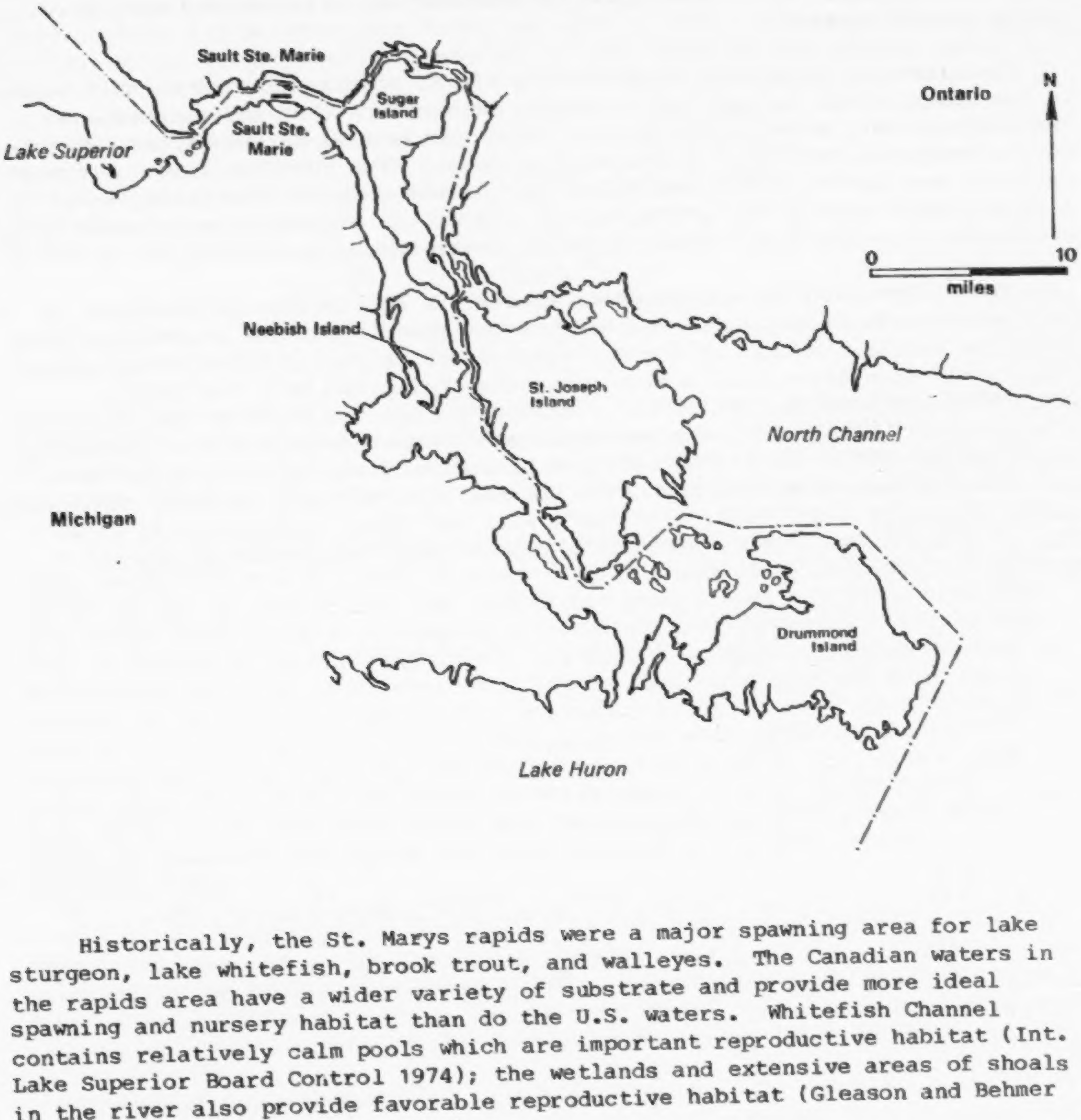
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North Channel
Michigan
Drummond Island
Lake Huron

Historically, the St. Marys rapids were a major spawning area for lake sturgeon, lake whitefish, brook trout, and walleyes. The Canadian waters in the rapids area have a wider variety of substrate and provide more ideal spawning and nursery habitat than do the U.S. waters. Whitefish Channel contains relatively calm pools which are important reproductive habitat (Int. Lake Superior Board Control 1974); the wetlands and extensive areas of shoals in the river also provide favorable reproductive habitat (Gleason and Behmer 1975; Jaworski and Raphael 1978a).

More than 60 species of fish have been recorded as residents, or migrants, in the St. Marys River (Behmer and Gleason 1975; Int. Lake Superior Board Control 1974; Liston, pers. comm. 1979; MWRC 1975; Odin 1979). This volume describes the reproductive habitat used by the 35 species for which information was available. Twenty-seven species treated in this volume were native to the river. Most of these 27 native species spawned in tributaries to the river, in the shallow bays and shoreline areas, or in the St. Marys rapids. Sturgeon is the only species believed to spawn in deeper areas in the river channel.

The eight exotic species treated in this volume have been introduced by man or have immigrated into the river from populations established elsewhere in the Great Lakes drainage. Four of these are salmonids that spawn in the rapids or in tributaries. Smelt also spawn in tributaries; alewives and carp spawn in the protected bays.

Information on nursery areas used by the 35 species treated in this volume is fragmentary, but as would be expected, it suggests that tributaries and nearshore waters, especially the bays, are important as nursery areas, at least for the earliest life history stages. Dispersal from spawning areas is rapid for some species which have small, pelagic larvae, whereas the juveniles of most salmonids that spawn in the rapids area or in tributaries may remain in or near those spawning areas for at least one year before dispersing.

The information for each species treated in this volume is presented by geographic region starting at the head of the river. For the purposes of this atlas, we define the head of the St. Marys River as that portion of the river immediately downstream from a line connecting Point Iroquois (46°29'05", 84°37'50") and Gros Cap (46°31'45", 84°35'15"); and the mouth of the St. Marys River as that portion of the river immediately upstream from a line connecting Point DeTour (45°57'30", 83°54'35") and Barbed Point (45°57'50", 83°52'55"). The river is separated from the North Channel of Lake Huron by lines connecting Koskhawong Point (46°07'50", 83°48'50") with Hay Point (46°05'30", 83°43'40") and Canoe Point (46°17'50", 83°55'35") with Woodman Point (46°18'10", 83°52'35").

SEA LAMPREY

The sea lamprey presumably entered the St. Marys River from Lake Huron, where its presence was first recorded in 1937. Spawning occurs in the river and its tributaries generally in May-July but may extend into August in areas influenced by the cold outflow of Lake Superior (Int. Great Lakes Levels Board 1973). Ammocoetes are sparse in the river above the locks at Sault Ste. Marie (46°30'00", 84°21'00"), abundant in the St. Marys Rapids (46°30'30", 84°21'15"), and present in significant numbers as far as 23 mi downstream from the rapids (Smith and Tibbles 1980) and in bays off stream mouths (SLCC 1979b). The following sites support spawning based on the presence of ammocoetes, spawning adults, or both.

Waiska River (46°24'50", 84°34'30") (Erkkila et at. 1956; FWS 1979a; Moore and Braem 1965; Smith and Braem 1976; Smith et al. 1974; Torblaa and Westman 1980).

Big Carp River (46°30'00", 84°26'30"), Little Carp River (46°30'20", 84°26'20"), and East and West Davignon Creeks (46°31'20", 84°22'50") (Dames and Moore 1978; GLFC 1973b; Price 1955, 1956; SLCC 1979b; Smith et al. 1974; Tibbles 1975; Tibbles et al. 1976a; Torblaa and Westman 1980).

St. Marys Rapids (46°30'30", 84°21'15") (Braem and Rugen 1976; GLFC 1975; Smith and Tibbles 1980; Tibbles 1975; Tibbles et al. 1976a). Whitefish Island (46°30'35", 84°21'00") has been a spawning area since the late 1950s (Dustin 1975). Successful spawning occurs above the island and also in Whitefish Channel (46°30'40", 84°21'00"). Most of the ammocoetes concentrate in quiet water over sand bottom along the drop off adjacent to the east side of the island. Some ammocoetes are also found in pockets of sand, silt, and fine gravel along the south and west sides of the island and also just below the compensating gates (Dustin 1975; Int. Great Lakes Level Board 1973; Int. Lake Superior Board Control 1974; Schleen 1974; SLCC 1979b). The U.S. portion of the rapids contains mainly large flat rocks and boulders and has no suitable spawning or nursery habitat (Schleen 1974).

Root River (46°32'30", 84°12'25"), Garden River (46°31'50", 84°09'25"), Echo River (46°30'20", 84°03'40"), and Bar River (46°25'30", 84°06'15") (FWS 1979c; SLCC 1979a,b; Smith and Tibbles 1980; Tibbles 1959; Tibbles et al. 1976a,b; Torblaa and Westman 1980). Ammocoetes have also been found off the mouths of the Root and Echo rivers (SLCC 1979b).

Desbarats River (46°20'10", 83°55'45") (MacKay and MacGillivray 1949).

Little Munuscong (46°12'55", 84°15'20") and Munuscong (46°12'30", 84°15'20") Rivers (GLFC 1973b; Torblaa and Westman 1980). In 1948, spawning was observed in Taylor Creek, a tributary of the Munuscong River, in June (Applegate 1950).

Sucker Creek (46°17'15", 83°57'20"), Two Tree River (46°12'05", 84°04'30"), Richardson Creek (46°10'55", 84°03'25"), Watson Creek (46°09'05", 83°53'30"), Brown's Creek (46°09'35", 83°52'15"), Gordon Creek (46°09'10", 83°53'35"), and Carlton Creek (46°03'15", 84°01'30") (FWS 1979c; GLFC 1975; SLCC 1979a,b; Tibbles 1959; Tibbles 1959; Tibbles et al. 1976a,b; Torblaa and Westman 1980). Ammocoetes have also been found in Tenby Bay (46°08'35", 83°52'00") (SLCC 1979b).

LAKE STURGEON

The St. Marys Rapids area (46°30'30", 84°21'15") was historically a spawning ground for the sturgeon (FWS 1979d; Odin 1979). Spawning was also historically observed in the rock area in the channel between East Neebish Island (46°20'30", 84°06'40") and Sugar Island (46°28'00", 84°12'30"), just north of Homestead (46°20'15", 84°07'20") (Hiltunen, pers. comm. 1980).

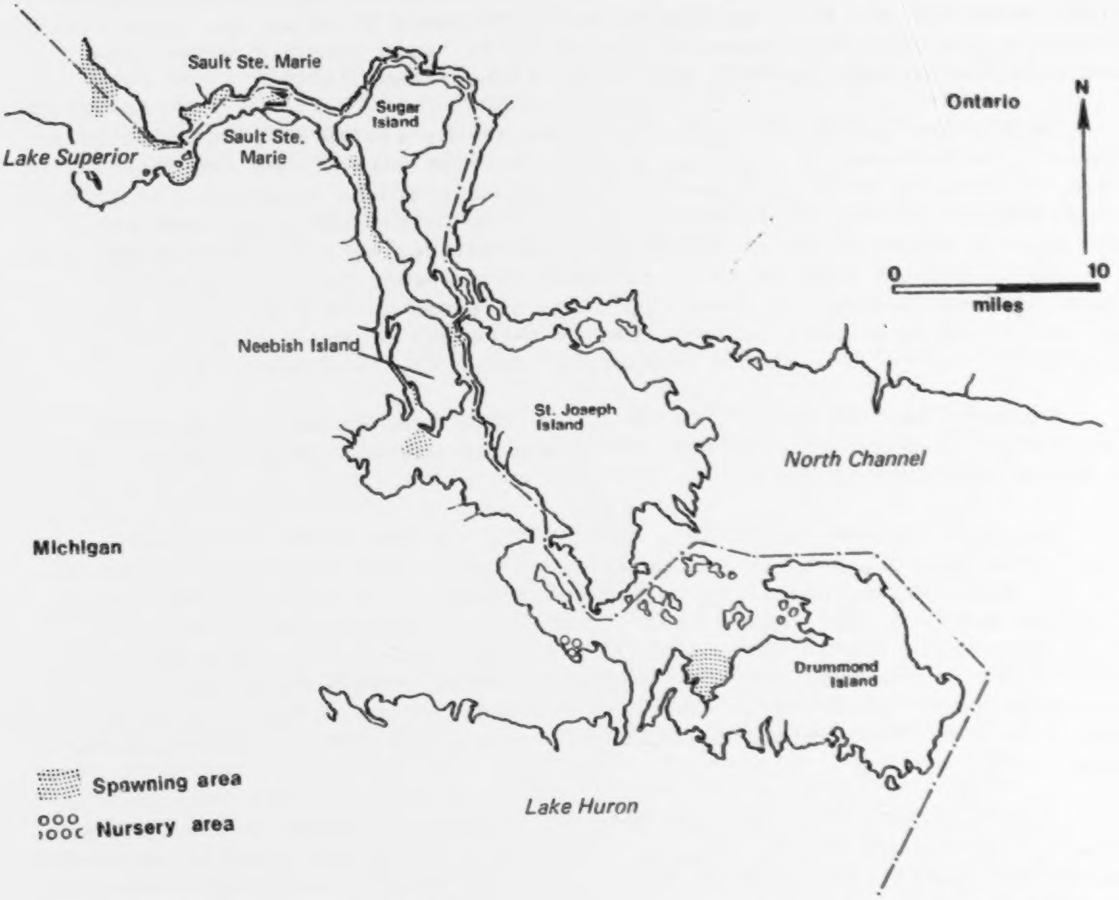
ALEWIFE

The alewife presumably entered the St. Marys River from Lake Huron in the late 1940s or early 1950s (Miller 1957). Alewives spawn in the St. Marys River, and it is also a nursery area (FWS 1977). Alewives may spawn in small numbers in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978).

LAKE HERRING

Information dating back to the early 1900s suggests that spawning occurred in the lower St. Marys River (MacDonald 1977, as cited in Gleason et al., undated). The river is a spawning and nursery ground (FWS 1977). A spawning migration occurs in the river, which provides recruits to stocks in Lake Huron (Odin 1979). Interviews with commercial fishermen suggest that spawning occurs in southern Lake Nicolet (46°21'30", 84°12'30") and Munuscong Bay (46°12'00", 84°12'30") between Kemps Pt. (46°13'55", 84°11'10") and Moon Island (46°12'55", 84°10'00") (Gleason et al., undated).

LAKE WHITEFISH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Lake Superior
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10
miles
Neebish Island
St. Joseph Island
North Channel
Michigan
Drummond Island
Spawning area
Nursery area
Lake Huron

Fishermen reported that there were once major spawning runs into the river from Lake Superior (Goodier, pers. comm. 1979). Indians claimed, however, that Lake Superior whitefish never ran down to the rapids and that St. Marys River whitefish never ascended to Lake Superior (Milner 1874a). Whitefish from Lake Huron ascended the St. Marys River to spawn (Stockwell 1875a). Whitefish congregated in large numbers for spawning in the St. Marys River (Milner 1874a), usually in October and November (Westerman and Van Oosten 1939). Whitefish that spawned in the river were once abundant at the outlet of Lake Superior, but stocks declined, possibly because the deposition of woody materials from lumbering activities degraded the habitat (Lawrie and Rahrer 1972, 1973). Whitefish presently spawn in the St. Marys River, especially in shoal areas, and it is a nursery ground (FWS 1977).

Gros Cap (46°31'45", 84°35'15")--Pte. aux Chenes (46°28'30", 84°31'30"). The shoals on the north side of the river and south of Chene Island (46°30'05", 84°33'00") were used for spawning (Goodier, per. comm.

1979). Large numbers of fish in spawning condition are taken here in mid-November indicating that this is an important spawning area (Wohlgemuth 1978). Five eggs believed to be whitefish eggs were collected from the bottom off Pte. aux Chenes during February 27-March 13, 1979. This area has excellent spawning potential; it has a constant water flow and a bottom of sand, gravel, and larger stones (Rosa 1979).

Mark's Bay (46°29'25", 84°27'30")--Leigh Bay (46°30'35", 84°25'30"). Spawning is believed to occur in Mark's and Leigh bays (Dames and Moore 1978; Wohlgemuth 1978), and confirmatory studies are in progress. In 1978 large numbers of ripe fish were collected from Mark's and Leigh bays in gillnets at depths of 18 ft and less. Peak catches occurred from about the end of October through the first week in November in this important spawning area (Wohlgemuth 1978). One egg believed to be a whitefish egg was collected on a sandy bottom close to the mouth of the Big Carp River (46°30'00", 84°26'30") during February 27-March 13, 1979 (Rosa 1979).

Mosquito Bay (46°26'40", 84°28'40"). Ripe females were collected here in gillnets in October (FWS 1977), and the bay was identified as a spawning area (FWS 1979d).

St. Marys Rapids (46°30'30", 84°21'15"). In the 1760s, whitefish were taken with dip nets in September and October from the shoals around the St. Marys Falls, but it is not known if these were spawning-run fish (Kumlien and True 1887; MSBCF 1893). In 1824 whitefish were abundant at Sault Ste. Marie (46°30'00", 84°21'00") during October 8-16 (MacDonald 1978). The rapids area is an historical spawning ground which may be presently used. Spawning in this area probably occurs at depths greater than 2 ft (FWS 1979d; Gleason and Behmer, pers. comm. 1979; Goodier, pers. comm. 1979).

Sugar Island (46°28'00", 84°12'30"). Fishermen stated that spawning occurred on the west shore of Sugar Island from Wasig Bay (Baie de Wasai) (46°27'45", 84°15'15") south to Shingle Bay (46°21'40", 84°10'40") and around the small rocky islands north of Ninemile Point (46°23'35", 84°13'40"). Suitable substrate exists in the area off the southwest corner of Sugar Island (46°20'00", 84°10'00"). Divers reported that this substrate extended from the southwest corner of Sugar Island across the channel to Neebish Island (46°16'30", 84°09'30"); however, fishermen did not report this as a spawning area (Gleason et al., undated).

Neebish Island (46°16'30", 84°09'30"). Fishermen indicated that the northeast corner of Neebish Island just east of Hen Island (46°18'40", 84°07'40") is a possible spawning site, but suitable habitat in this area was found only at the largest island of the Chicken Islands group (46°18'20", 84°07'35"). One fisherman suggested that spawning may take place along a line from Roach Point (46°11'10", 84°10'40") to Conley's Point (Kemps Pt., 46°13'55", 84°11'10") adjacent to the Moon Islands (46°12'55", 84°10'00"). Another fisherman reported that spawning may occur off the north end of Neebish Island near buoy 52 (46°22'10", 84°13'15") of the downbound shipping channel. The area just down river of the south dike of Rock Cut (46°15'05", 84°10'35") was reported to be a major spawning area; this area is on or near a site that was dredged in the early 1960s (Gleason et al., undated). Another suspected spawning area (46°13'05", 84°05'40") lies just southeast of Neebish Island (Odin 1979).

Maud Bay (46°01'30", 83°58'20"). In 1974, young-of-the-year (YOY) whitefish were collected in tow-nets off Maud Bay in September and October; sixty YOY were also taken in bottom trawls in Maud Bay in early October (Behmer and Gleason 1975).

Sturgeon Bay (46°01'00", 83°48'00"). Whitefish historically spawned here during November 15-30 (Van Oosten 1927a).

COREGONUS spp.

Rocky Point (46°10'45", 84°07'20"). In 1979, several eyed-stage coregonid eggs were collected in dredge samples taken in about 6 ft of water on a hard sand bottom off the east shore of Rocky Point on March 12 (Gleason et al., undated).

PINK SALMON

Since this species was accidentally released in 1956 into Canadian waters of Lake Superior, self-sustaining populations have spread to all the Great Lakes (Wagner 1979). No information was found concerning the first occurrence of pink salmon in the St. Marys River; however, the first recorded capture of pink salmon in Lake Huron occurred in 1969 (Wagner 1974a). These fish presumably entered Lake Huron from Lake Superior via the St. Marys River. In 1979, a run of pink salmon was observed in the river (Wagner 1979). The rapids area near Whitefish Island (46°30'35", 84°21'00") is probably a spawning ground; pink salmon move into this region during the spawning season, and dead adults have been observed there (Gleason and Behmer, pers. comm. 1979). Whitefish Channel (46°30'40", 84°21'00") and protected pockets on the south edge of Whitefish Island have gravel substrate suitable for spawning (Int. Lake Superior Board Control 1974).

COHO SALMON

The first recorded capture of coho salmon in the St. Marys River occurred in the late 1960s (OMNR 1976b); presumably these fish originated from plantings made in Lake Superior in 1966 or Lake Huron in 1967 (Parsons 1973). Occasional catches of coho salmon are made in the St. Marys River (OMNR 1976b), suggesting that spawning may occur there. The Big Carp River (46°30'00", 84°26'30") and Little Carp River (46°30'20", 84°26'20") are significant spawning and nursery grounds for coho salmon

(Dames and Moore 1978). Whitefish Channel (46°30'40", 84°21'00") and protected pockets on the south edge of Whitefish Island (46°30'35", 84°21'00") have gravel substrate suitable for spawning (Int. Lake Superior Board Control 1974).

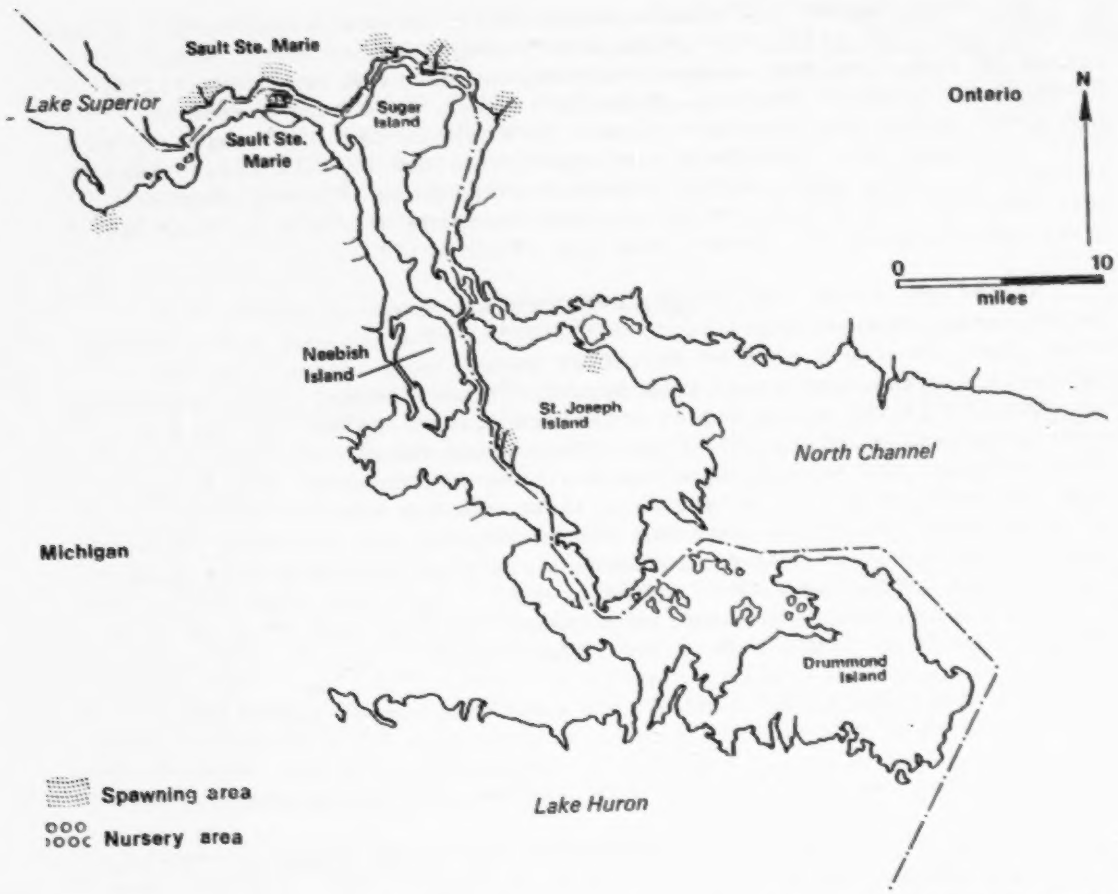
CHINOOK SALMON

The first recorded capture of chinook salmon in the St. Marys River occurred in the late 1960s (OMNR 1976b); presumably these fish originated from plantings made in Lake Superior or Lake Huron in 1967 (Parsons 1973). The mid-river portion of the rapids area near Whitefish Island (46°30'35", 84°21'00") is believed to be a spawning ground; ripe and dead, spent fish have been observed there, but reproduction may not be successful. Substrate in this area ranges from rubble to large boulders (Gleason and Behmer, pers. comm. 1979). Whitefish Channel (46°30'40", 84°21'00") and protected pockets on the south edge of Whitefish Island have gravel substrate suitable for spawning (Int. Lake Superior Board Control 1974).

ROUND WHITEFISH

Round whitefish may spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays, but there appears to be an absence of gravel and rock substrate in this area (Dames and Moore 1978).

RAINBOW TROUT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Lake Superior
Sault Ste. Marie
Sugar Island
Ontario
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miles
Neebish Island
St. Joseph Island
North Channel
Michigan
Drummond Island
Lake Huron
Spawning area
Nursery area

Rainbow trout were first introduced into the St. Marys River in 1883 by the Ontario Government and were abundant in the river after 1900 (MacCrimmon and Gots 1972). Spawning runs may occur in the spring or fall, but most spawning occurs in the spring (OMNR 1976b). A major run of rainbow trout occurs in the river (Environ. Can. 1977c; Odin 1979; OMNR 1976b). Sportsmen believed that most spawning areas were located on the Canadian side of the river because the U.S. side did not have adequate amounts of sand or gravel substrate (Anderson 1952; Westerman 1952a). Spawning was reported at the following areas:

Waiska River (46°24'50", 84°34'30") (Moore and Braem 1965).

Big (46°30'00", 84°26'30") and Little (46°30'20", 84°26'20") Carp Rivers (Dames and Moore 1978; OMNR 1976b; Price 1955).

Roundwood Creek (46°30'50", 84°24'45") and Bennett Creek (46°31'40", 84°23'10") (OMNR 1976b).

East and West Davignon Creeks (46°31'20", 84°22'50") (OMNR 1976b; Price 1955).

St. Marys Rapids (46°30'30", 84°21'15"). Natural reproduction occurs in this area (FWS 1979; Odin 1979; Proctor and Redfern 1978), which has a bottom of rock, boulder, exposed bedrock, gravel, and sand (FWS 1979d). Spawning occurred in May (Ont. Game Fish 1912). The rapids area in mid-river, where the substrate ranges from rubble to large boulders, is used for spawning. Young have also been collected in this area (Gleason and Behmer, pers. comm. 1979). Spawning conditions in the rapids are best when all the control gates are open; a large decrease in flow can leave the spawning and nursery beds dry (Purych 1972).

Whitefish Island (46°30'35", 84°21'00"). Spawning takes place in the Whitefish Channel (46°30'40", 84°21'00"). The channel and protected areas along the south side of Whitefish Island have suitable gravel substrate for spawning (Int. Lake Superior Board Control 1974). Spawning has occurred in the south end of Whitefish Channel in May and June at water temperatures of 42-55°F (Int. Great Lakes Levels Board 1973). In 1953, spawning may have occurred on a stream on Whitefish Island; 20 spawning redds were counted and many large rainbow trout were seen "chasing about" on May 6, when the stream temperature was 45°F. However, spawning did not appear to be successful, because only dead eggs were found in the redds (Loeb 1953; Moffett 1954). Parr less than 1 in. long found at the south end of Whitefish Channel indicate that this is a nursery area (Int. Great Lakes Level Board 1973).

Root River (46°32'30", 84°12'25") and Garden River (46°31'50", 84°09'25") (OMNR 1976b).

Echo River (46°30'20", 84°03'40") (MacCrimmon and Gots 1972).

Two Tree River (46°12'05", 84°04'30") and Sucker Creek (46°17'15", 83°57'20") (OMNR 1976b).

BROOK TROUT

Brook trout spawn in Whitefish Channel (46°30'40", 84°21'00") (Int. Great Lakes Level Board 1973). Big (46°30'00", 84°26'30") and Little (46°30'20", 84°26'20") Carp rivers have rubble and gravel substrate and are significant spawning and nursery grounds; most of the fish using these streams are residents, but some fish move into them from the St. Marys River to spawn (Dames and Moore 1978).

LAKE TROUT

Until 1950, a small area at the southwest end of Portlock Island (46°18'30", 83°54'40") was used for spawning in late October (Smith 1968). A spawning migration occurs in the river (Odin 1979). The dominant substrate in the channel along the north shore of St. Joseph Island (46°13'00", 84°00'00") from Portlock Island to East Neebish Island (46°20'30", 84°06'40") and Maskinonge Bay (46°20'15", 84°05'00") is honeycombed rock and is excellent spawning habitat (Smith 1968), but spawning has not been documented there.

RAINBOW SMELT

Rainbow smelt eggs planted in the St. Marys River system in 1906 are believed to be the first introduction of this species to the Great Lakes, however, this and subsequent plantings of smelt eggs in the river are thought to have been unsuccessful. Smelt eggs planted in Crystal Lake (44°40', 86°10') (Lake Michigan drainage) in 1912 are believed to be the source of smelt found in all the Great Lakes except Lake Ontario (Van Oosten 1937a). Smelt were first reported in the St. Marys River in the early 1930s (Dymond 1944; Van Oosten 1937a). Records of dispersal suggest that smelt entered the river from Lake Huron (Van Oosten 1937a). In 1933, smelt entered Stoby (Stobie) Creek (46°20'00", 83°53'05") near Portlock (46°20'30", 83°53'00") in mid-April to mid-May (Savage 1935). In mid-late April 1935, the first runs occurred on Drummond Island (46°00'00", 83°40'00") in Pigeon Cove Creek (45°59'15", 83°47'45"), in small streams 1/2 mi E of Drummond Island, and at Sault Ste. Marie (46°30'00", 84°21'00") (Van Oosten 1937a).

Spawning begins in the St. Marys River in early April and lasts about 3 weeks (MacKay 1969). Spawning occurs on the rocky shores of the river and in tributaries (FWS 1977; Liston, pers. comm. 1979). The river is also a nursery ground (FWS 1977).

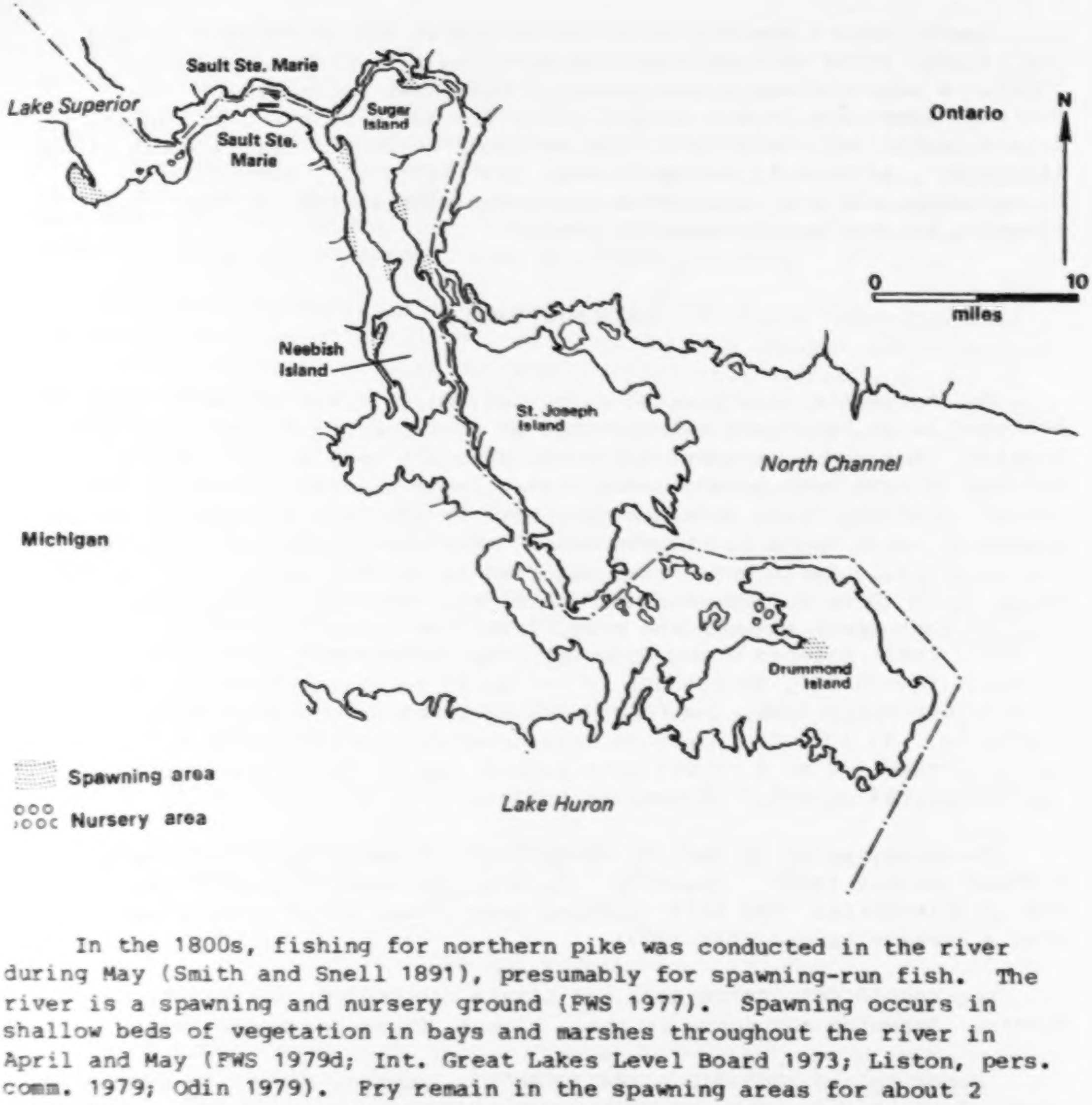
Big (46°30'00", 84°26'30") and Little (46°30'20", 84°26'20") Carp Rivers. Spawning may occur in these rivers (Dames and Moore 1978).

Sugar Island (46°28'00", 84°12'30"). Spawning occurs in some years in rivulets on the north end of the island (Hiltunen, pers. comm. 1980).

Echo River (46°30'20", 84°03'40") and Two Tree River (46°12'05", 84°04'30"). In 1968, a few smelt were caught in these rivers in the Canadian Department of Fisheries and Oceans sea lamprey weir (FWS 1979c).

Maud Bay (46°01'30", 83°58'20"). In 1974, young-of-the-year smelt were caught in bottom trawls in Maud Bay on October 3-4 (Behmer and Gleason 1975).

NORTHERN PIKE


Sault Ste. Marie
Lake Superior
Sugar Island
Sault Ste. Marie
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miles
Neebish Island
St. Joseph Island
North Channel
Michigan
Drummond Island
Spawning area
Nursery area
Lake Huron

In the 1800s, fishing for northern pike was conducted in the river during May (Smith and Snell 1891), presumably for spawning-run fish. The river is a spawning and nursery ground (FWS 1977). Spawning occurs in shallow beds of vegetation in bays and marshes throughout the river in April and May (FWS 1979d; Int. Great Lakes Level Board 1973; Liston, pers. comm. 1979; Odin 1979). Fry remain in the spawning areas for about 2 weeks until they absorb their yolk sacs (Int. Great Lakes Level Board 1973).

Waiska Bay (46°26'00", 84°35'40"). Ripe adults have been collected here (Gleason and Behmer, pers. comm. 1979).

Mosquito Bay (46°26'40", 84°28'40"). Spawning may occur in the bay (Gleason and Behmer, pers. comm. 1979).

Mark's Bay (46°29'25", 84°27'30")--Leigh Bay (46°30'35", 84°25'30"). Spawning may occur in the nearshore areas of these bays (Dames and Moore 1978).

Frog Bay (46°31'50", 84°11'45"). Spawning was observed in late April during the late 1940s and early 1950s in the marshy areas of the bay. Spawning pairs were observed in a floating mat of marsh five-finger (Potentilla palustris) that composed part of the vegetation in the zone of sedges (Carex spp.) and willows (Salix spp.). In recent years the density of the horsetail (Equisetum spp.) has declined and fewer northern pike have been seen in the bay (Hiltunen, pers. comm. 1979).

Wasig Bay (46°27'45", 84°15'15"). Ripe adults were collected in Wasig Bay. Ninemile Point (46°23'35", 84°13'40"). Spawning occurs among vegetation across the channel from Ninemile Point and is usually completed by about May 1. Whipple Point (46°25'15", 84°11'20"). Spawning probably occurs from Whipple Point to the south, for an unstated distance. Shingle Bay (46°21'40", 84°10'40"). Ripe adults have been collected here. Maskinonge Bay (46°20'15", 84°05'00"). Spawning probably occurs here. Sand (Jones) Bay (46°18'30", 84°12'00"). Spawning occurs here (Gleason and Behmer, pers. comm. 1979).

West Neebish Channel (46°16'30", 84°12'00"). Spawning may occur in the channel (Odin 1979).

Potagannissing River (46°02'20", 83°40'15"). Spawning adults have been observed ascending the river (Hiltunen, pers. comm. 1980).

CARP

Carp were present in the St. Marys River as early as 1920 and presumably originated from populations in Lake Huron (McCrimmon 1968).

Frog Bay (46°31'50", 84°11'45"). A population resides in the bay and presumably spawns there (Hiltunen, pers. comm. 1980).

Shingle Bay (46°21'40", 84°10'40"). Spawning carp have been observed in the bay (Gleason and Behmer, pers. comm. 1979).

Munuscong Bay (46°12'30", 84°15'20"). Carp arrived in Munuscong Bay in June in large numbers, presumably to spawn (Westerman and Van Oosten 1939).

EMERALD SHINER

Young-of-the-year are generally common near the shoreline of dredge spoil islands in the St. Marys River (FWS 1977). Spawning occurs in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978).

SPOTTAIL SHINER

Young-of-the-year (YOY) were collected in shallow water over the large sand bars around the spoil islands in Mosquito Bay (46°26'40", 84°28'40"); they are common in seine catches in this type of habitat (FWS 1977). Spottail shiners spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978). Large numbers of YOY were caught in Maud Bay (46°01'30", 83°58'20") bottom trawls (Behmer and Gleason 1975).

MIMIC SHINER

Mimic shiners may spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978).

NORTHERN REDBELLY DACE

Northern redbelly dace spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978).

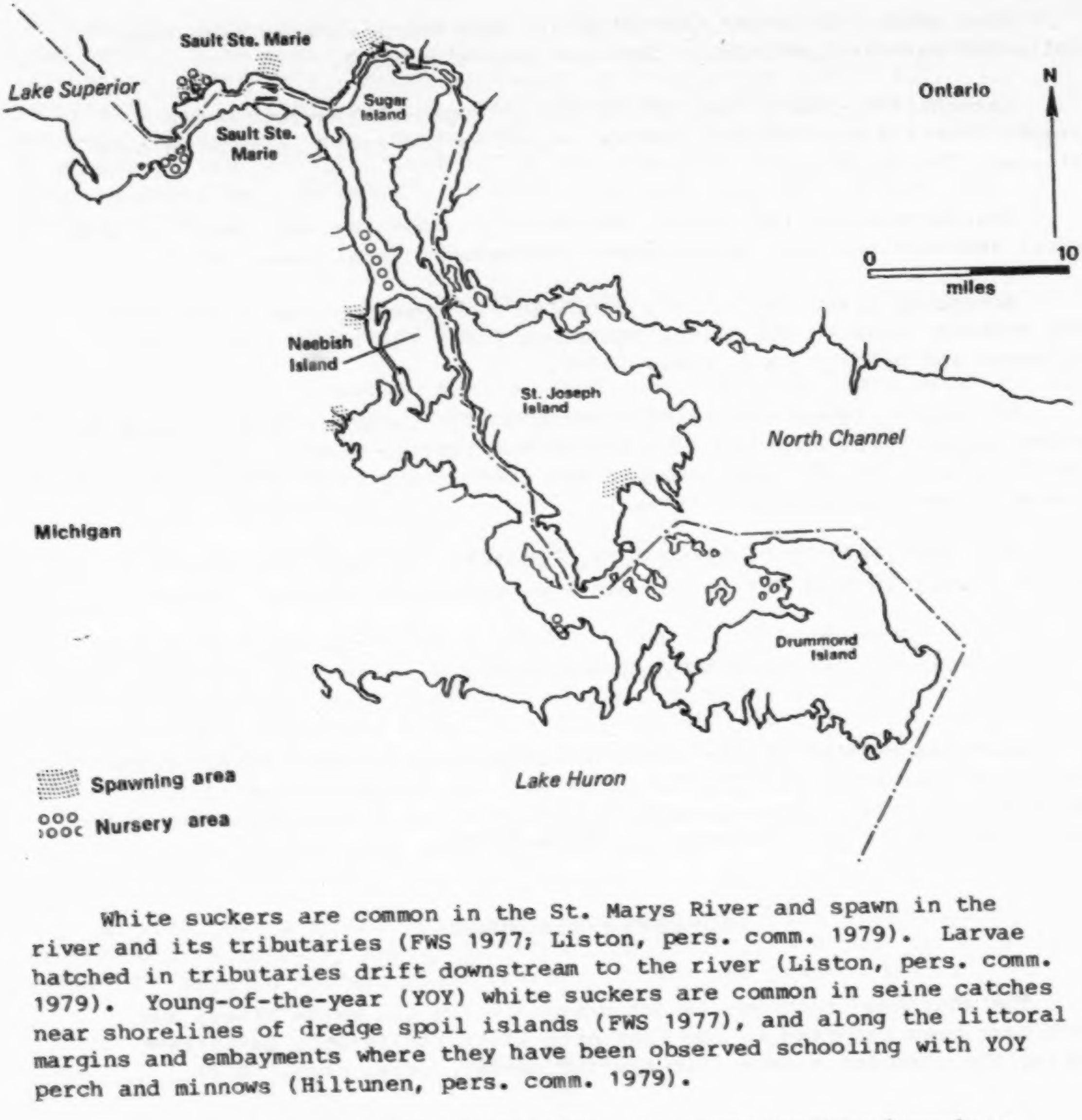
CYPRINID spp.

In early summer, unidentified minnow postlarvae have been seen migrating in small schools upstream along the littoral margin of Little Lake George (46°32'40", 84°11'15"). These schools often frequent shallow embayments or weed beds in waters deeper than 6 ft (Hiltunen, pers. comm. 1979).

LONGNOSE SUCKER

A small population of longnose suckers may spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays; however, the area generally lacks the gravel and rock substrate most suitable for spawning by this species. Spawning also may occur in Big (46°30'00", 84°26'30") and Little (46°30'20", 84°26'20") Carp rivers (Dames and Moore 1978).

WHITE SUCKER


Sault Ste. Marie
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Sault Ste. Marie
Sugar Island
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Neebish Island
St. Joseph Island
North Channel
Michigan
Drummond Island
Lake Huron
Spawning area
Nursery area

White suckers are common in the St. Marys River and spawn in the river and its tributaries (FWS 1977; Liston, pers. comm. 1979). Larvae hatched in tributaries drift downstream to the river (Liston, pers. comm. 1979). Young-of-the-year (YOY) white suckers are common in seine catches near shorelines of dredge spoil islands (FWS 1977), and along the littoral margins and embayments where they have been observed schooling with YOY perch and minnows (Hiltunen, pers. comm. 1979).

Mosquito Bay (46°26'40", 84°28'40"). Young-of-the-year have been caught in shallow water around spoil islands in the bay (FWS 1977).

Big (46°30'00", 84°26'30") and Little (46°30'20", 84°26'20") Carp Rivers. These rivers are significant spawning and nursery areas; the heavier run occurs in the Big Carp River (Dames and Moore 1978; Price 1955).

East and West Davignon Creek (46°31'20", 84°22'50"). Spawning runs occur from April into June (Price 1955).

Root River (46°32'30", 84°12'25"). Many white suckers have been collected here in April-July (Dahl and McDonald 1980).

Lake Nicolet (46°21'30", 84°12'30"). Young-of-the-year white suckers are the most common species seined at the spoil islands in Lake Nicolet (FWS 1977).

Charlotte River (46°19'05", 84°13'15"). Spawning runs begin in late April and continue into May (Gleason and Behmer, pers. comm. 1979).

Munuscong River (46°12'30", 84°15'20"). Spawning runs occur here and probably also in the Little Munuscong River (46°12'55", 84°15'20") (Gleason and Behmer, pers. comm. 1979).

St. Joseph Island (46°13'00", 84°00'00"). Large numbers of spawning white suckers were observed in mid-late May 1974 in Brown's Creek (46°09'35", 83°52'15") and Watson Creek (46°09'05", 83°53'30") on St. Joseph Island (Davis et al. 1975a).

Maud Bay (46°01'30", 83°58'20"). In 1974, YOY were captured in bottom trawls in Maud Bay on October 3-4 (Behmer and Gleason 1975).

SILVER REDHORSE

Spawning runs of silver redhorse begin in April and continue into May in the Charlotte (46°19'05", 84°13'15") and Munuscong (46°12'30", 84°15'20") rivers. Spawning may also occur in the Little Munuscong River (46°12'55", 84°15'20") (Gleason and Behmer, pers. comm. 1979).

SHORTHEAD REDHORSE

The shorthead redhorse is not common in the St. Marys River, but runs have been reported in the Charlotte River (46°19'05", 84°13'15") during the spawning season (Gleason and Behmer, pers. comm. 1979).

CATOSTOMID spp.

In early summer, unidentified catostomid postlarvae can be seen migrating in small schools upstream along the littoral margin of Little Lake George (46°32'40", 84°11'15"). These schools often frequent shallow embayments or weed beds in waters deeper than 6 ft (Hiltunen, pers. comm. 1979).

BROWN BULLHEAD

The St. Marys River is a spawning and nursery ground for this species (FWS 1977). Ripe fish were collected on spawning grounds in Wasig Bay (46°27'45", 84°15'15"). Spawning occurs in Shingle Bay (46°21'40", 84°10'40") and possibly also in Jones (Sand) Bay (46°18'30", 84°12'00") (Gleason and Behmer, pers. comm. 1979). Young-of-the-year were collected in Munuscong Bay (46°12'00", 84°12'30") in mid-July 1955 and in Potagannissing Bay (46°04'20", 83°45'00") in mid-July 1969 (Behmer and Gleason 1975).

TROUT-PERCH

Trout-perch may spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978); in 1974, young-of-the-year were collected in Maud Bay (46°01'30", 83°58'20") (Behmer and Gleason 1975).

BURBOT

Burbot may spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays, but these areas generally lack the gravel and rock on which burbot usually spawn (Dames and Moore 1978). Eggs collected at the southwest corner of Sugar Island (46°28'00", 84°12'30) have been tentatively identified as burbot eggs (Gleason et al., undated).

WHITE BASS

In 1973, young-of-the-year white bass were collected in Munuscong (46°12'00", 84°12'30"), Raber (45°06'00", 84°03'30"), and Maud (46°01'30", 83°58'20") bays in September and October (Behmer and Gleason 1975).

ROCK BASS

Rock bass may spawn in the nearshore areas of Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978).

PUMPKINSEED

Several young-of-the-year pumpkinseed were seined in Munuscong Bay (46°12'00", 84°12'30") on July 4, 1955 (Behmer and Gleason 1975).

SMALLMOUTH BASS

Bay Mills Point (Elisa's Point) (46°26'00", 84°35'00"). Adult smallmouth bass have been collected here during the spawning season; the substrate in the area is gravel (Gleason and Behmer, pers. comm. 1979).

Cedar Point (46°26'45", 84°30'00"). A resident population of smallmouth bass is assumed to spawn in the area; the substrate here is rubble and large rock (Gleason and Behmer, pers. comm. 1979).

Mark's Bay (46°29'25", 84°27'30")--Leigh Bay (46°30'35", 84°25'30"). Spawning may occur here, but the area generally lacks gravel substrate suitable for spawning (Dames and Moore 1978).

Duck Lake (46°21'40", 84°08'40"). The shallow water at the outlet of Duck Lake was a known spawning area for smallmouth bass (MSBFC 1909a).

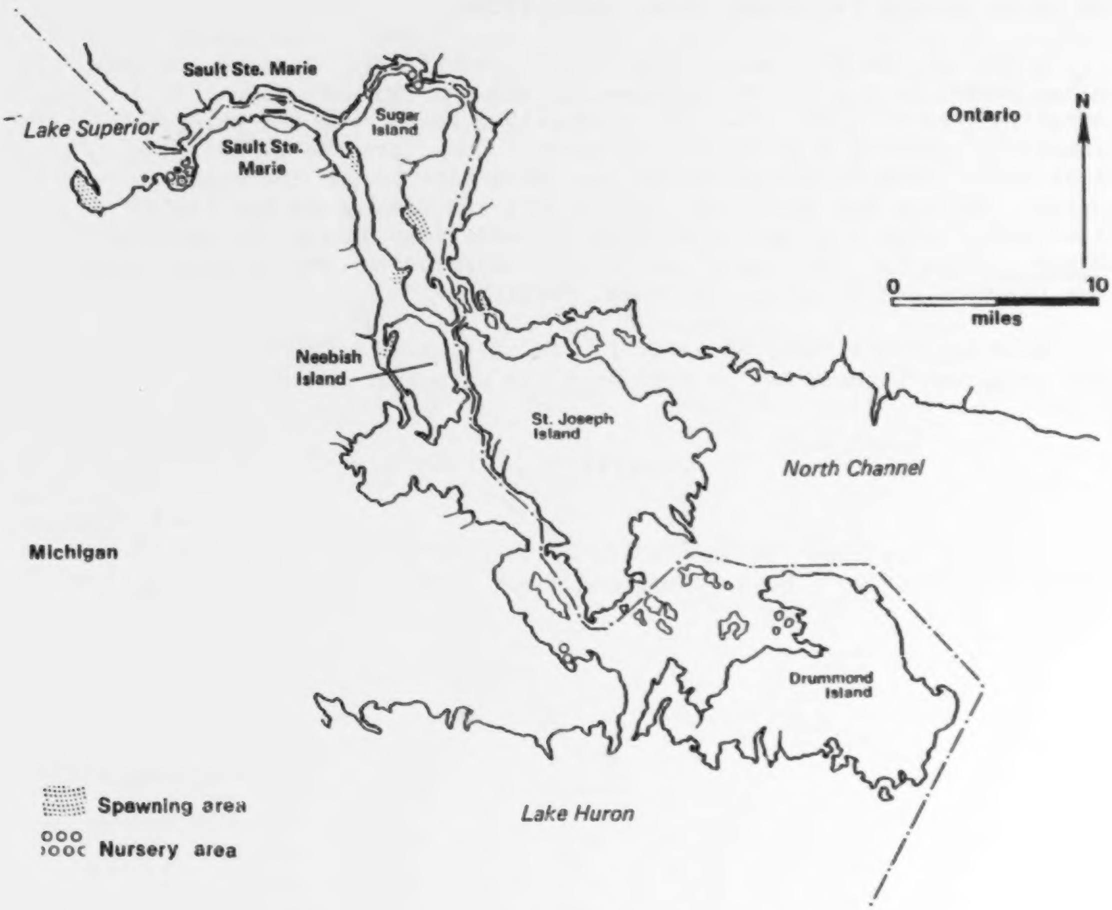
Moon Island (46°12'55", 84°10'00"). Moon Island, and adjacent spoil areas, may be spawning areas (Gleason and Behmer, pers. comm. 1979).

JOHNNY DARTER

Mark's Bay (46°29'25", 84°27'30")--Leigh Bay (46°30'35", 84°25'30"). Johnny darters spawn in these bays (Dames and Moore 1978).

Little Lake George (46°32'40", 84°11'15"). Males have been found guarding eggs deposited underneath sunken, waterlogged flotsam along the shore of Little Lake George (Hiltunen, pers. comm. 1980).

YELLOW PERCH


Sault Ste. Marie
Lake Superior
Sault Ste. Marie
Sugar Island
Ontario
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0
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miles
Neebish Island
St. Joseph Island
North Channel
Michigan
Drummond Island
Lake Huron
Spawning area
Nursery area

Yellow perch are common in the St. Marys River. Spawning occurs in the spring, probably near littoral areas (FWS 1977; Liston, pers. comm. 1979) among rooted vegetation and debris (FWS 1979d; Odin 1979).

Waiska Bay (46°26'00", 84°35'40"). Ripe fish were collected in this area during the spawning season (Gleason and Behmer, pers. comm. 1979).

Mosquito Bay (46°26'40", 84°28'40"). Ripe adults were collected here, usually during the first week in June, but as late as mid-June. Ripe fish are present in this area later than other areas. Young-of-the-year (YOY) have been caught in shallow water around the spoil islands in the bay (FWS 1977; Gleason and Behmer, pers. comm. 1979).

Mark's Bay (46°29'25", 84°27'30")--Leigh Bay (46°30'35", 84°25'30"). Yellow perch may spawn here in the nearshore areas (Dames and Moore 1978).

Frog Bay (46°31'50", 84°11'45"). In early summer, YOY and older yellow perch congregate in Frog Bay, frequently schooling with shiners and YOY white suckers (Hiltunen, pers. comm. 1979).

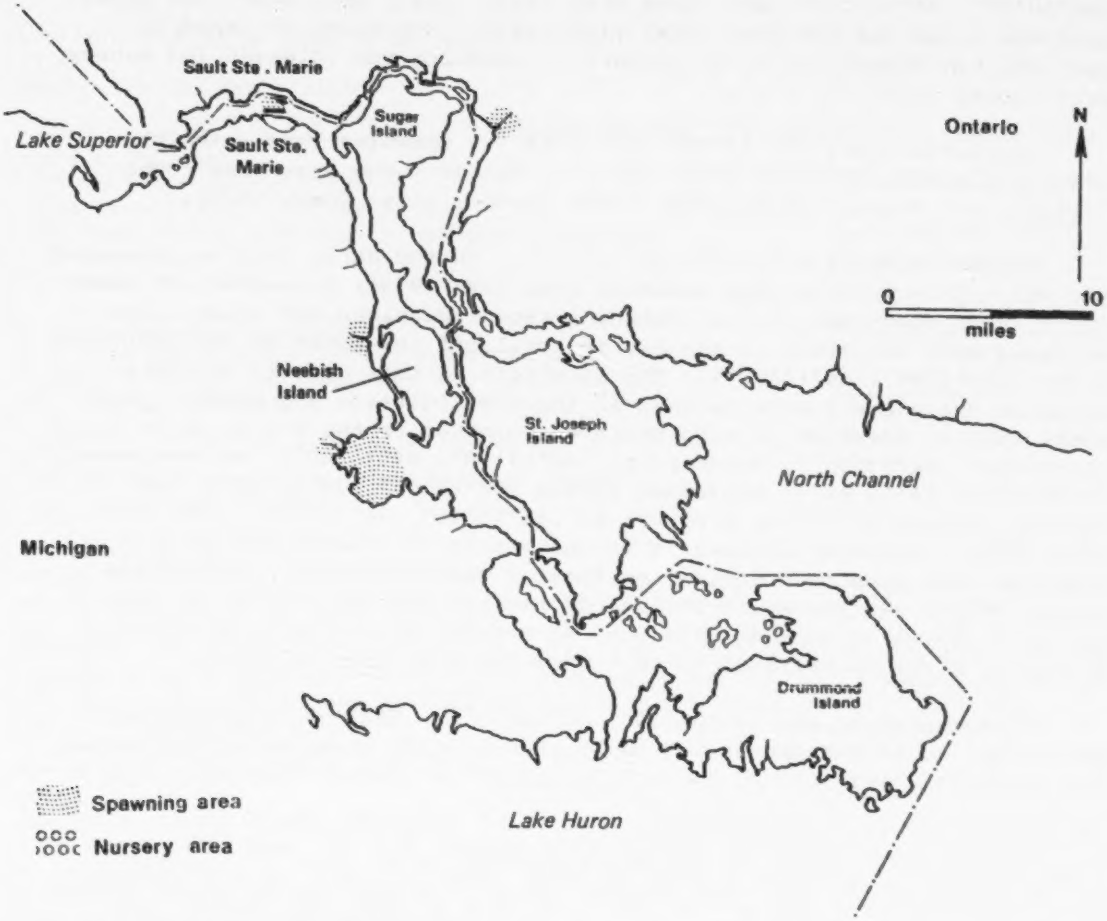
Wasig Bay (Baie de Wasai) (46°27'45", 84°15'15"). Ripe adults were collected in the bay during the spawning season. Whipple Point (46°25'15", 84°11'20"). The entire shoreline south from the point is probably a spawning area for yellow perch. Duck Lake (46°21'40", 84°08'40"). Fishing occurs for yellow perch here during the spawning season. Shingle Bay (46°21'40", 84°10'40") and Maskinonge Bay (46°20'15", 84°05'00"). Ripe fish were collected in these bays during the spawning season. Jones Bay (Sand Bay) (46°18'30", 84°12'00"). Yellow perch spawn here (Gleason and Behmer, pers. comm. 1979).

Maud Bay (46°01'30", 83°58'20"). In 1974, over 500 YOY yellow perch were collected in Maud Bay on October 3 and 4 (Behmer and Gleason 1975).

LOGPERCH

Logperch may spawn in Mark's (46°29'25", 84°27'30") and Leigh (46°30'35", 84°25'30") bays (Dames and Moore 1978).

WALLEYE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Sugar Island
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miles
Neebish Island
St. Joseph Island
North Channel
Michigan
Drummond Island
Spawning area
Nursery area
Lake Huron

In the 1800s, fishing for walleyes was conducted in the river during May (Smith and Snell 1891), presumably for spawning-run fish. Spawning occurred between Sault Ste. Marie (46°30'00", 84°21'00") and De Tour (45°59'30", 83°53'55"), and a fishery took large numbers of spawners there for many years (MSBFC 1911). Walleyes spawn in the lower river (Int. Lake Superior Board Control 1974) over rock and rubble in shallow areas subjected to currents (Int. Great Lakes Level Board 1973). The St. Marys River is also a nursery ground for walleye (FWS 1977).

Whitefish Channel (46°30'40", 84°21'00"). Walleyes spawn in the channel on Whitefish Island (46°30'35", 84°21'00") (Int. Lake Superior Board Control 1974).

St. Marys Rapids (46°30'30", 84°21'15"). Spawning has occurred in the rapids area (FWS 1979d).

Echo River (46°30'20", 84°03'40"). Spawn was collected in Echo Lake (46°30'20", 84°03'40") (Ont. Game Fish 1945, 1948), when many fish moved upstream under the ice (Ont. Game Fish 1945). According to Canadian sources, the Echo River still supports a spawning run (Gleason and Behmer, pers. comm. 1979).

Charlotte River (46°19'05", 84°13'15"). Spawning runs enter the Charlotte River, possibly under the ice, but no young have been found (Gleason and Behmer, pers. comm. 1979; Liston, pers. comm. 1979).

Munuscong Bay (46°12'00", 84°12'30"). In the early 1900's, Munuscong Bay was a principal walleye spawning area (FWS 1979d; Schneider and Leach 1977, 1979; Westerman 1927). During a recent Michigan DNR study, ripe walleyes were collected in the bay in April off the mouth of the Munuscong River (46°12'30", 84°15'20"). The substrate in this area is mainly silt, although there are rubble patches in the area (Gleason and Behmer, pers. comm. 1979). Spawning is also believed to occur in the bay at Birch Point (46°10'50", 84°09'00"), Roach Point (46°11'10", 84°10'40"), Barbeau Point (46°11'35", 84°14'45"), Munuscong Island (46°12'45", 84°14'30"), and between Barbeau Point and Maple Point (46°10'40", 84°11'40") (FWS 1979d; Odin 1979). Walleyes congregate in the bay in late March and early April reaching peak densities during the first 2 weeks of April (Gleason and Behmer 1975). Riffle areas in many of the tributaries to the bay are potential spawning grounds (Gleason and Behmer, pers. comm. 1979). The Munuscong River is believed to be a spawning area (FWS 1979d).

Potagannissing Bay (46°04'20", 83°45'00"). Walleyes congregated under the ice in Potagannissing Bay in March prior to spawning (Westerman and Van Oosten 1939).

SLIMY SCULPIN

Big (46°30'00", 84°26'30") and Little (46°30'20", 84°26'20") Carp Rivers. Slimy sculpins may spawn in these streams (Dames and Moore 1978).

St. Marys Rapids (46°30'30", 84°21'15"). Spawners were collected in mid-river in the rapids area, where the substrate ranges from rubble to large boulders (Gleason and Behmer, pers. comm. 1979).

Little Lake George (46°32'40", 84°11'15"). Slimy sculpin eggs have been observed underneath stones in Little Lake George (Hiltunen, pers. comm. 1979).

50272-101

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This document is one of a set of fourteen volumes.

16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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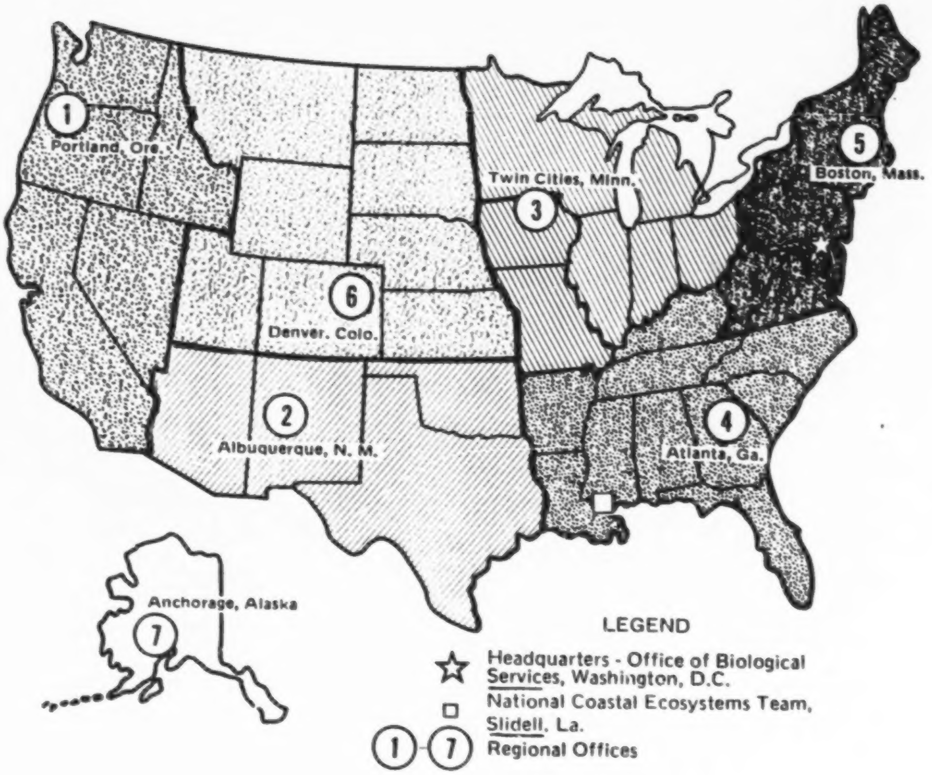
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82/52/v.4

Biological Services Program

FWS/OBS-82/52
SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume IV-Lake Michigan

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- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME IV
Lake Michigan

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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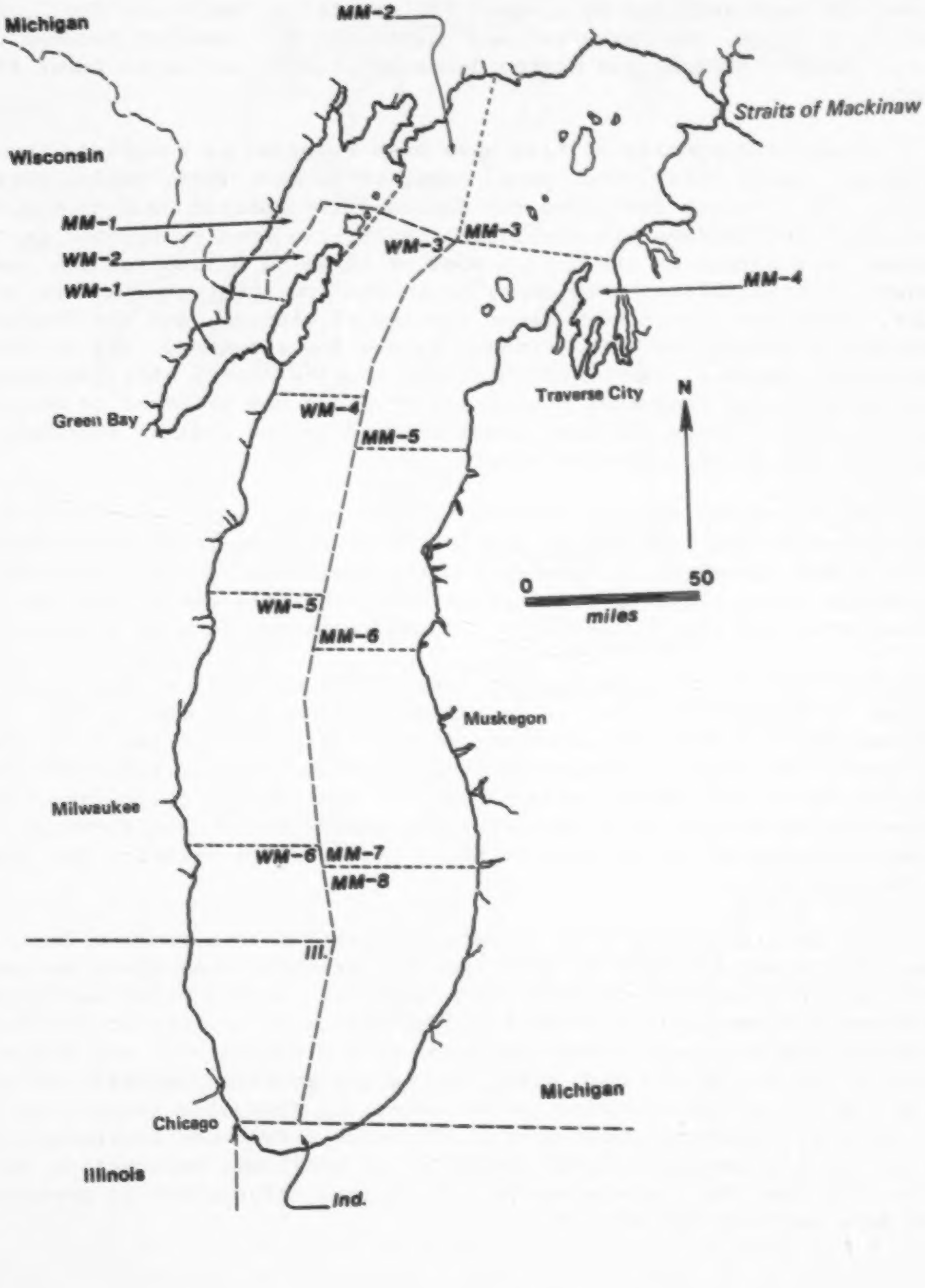
INTRODUCTION


MM-2
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Straits of Mackinaw
Wisconsin
MM-1
MM-3
WM-2
WM-3
WM-1
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
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Michigan
Chicago
Illinois
Ind.

Historically, large amounts of fish spawning habitat in Lake Michigan was destroyed or degraded by sawmill wastes, which covered spawning grounds in tributaries and near stream mouths, and by the construction of dams, which blocked spawning migrations into tributaries (Wells and McLain 1973). By the late 1800s, spawning grounds in Grand Traverse Bay and the Muskegon River had been degraded by sawdust (Milner 1874a; Smith and Snell 1891). By the early 1900s, the Fox River was unsuitable for spawning because of the large numbers of dams and bottom deposits of silt and paper fiber (Turner 1927).

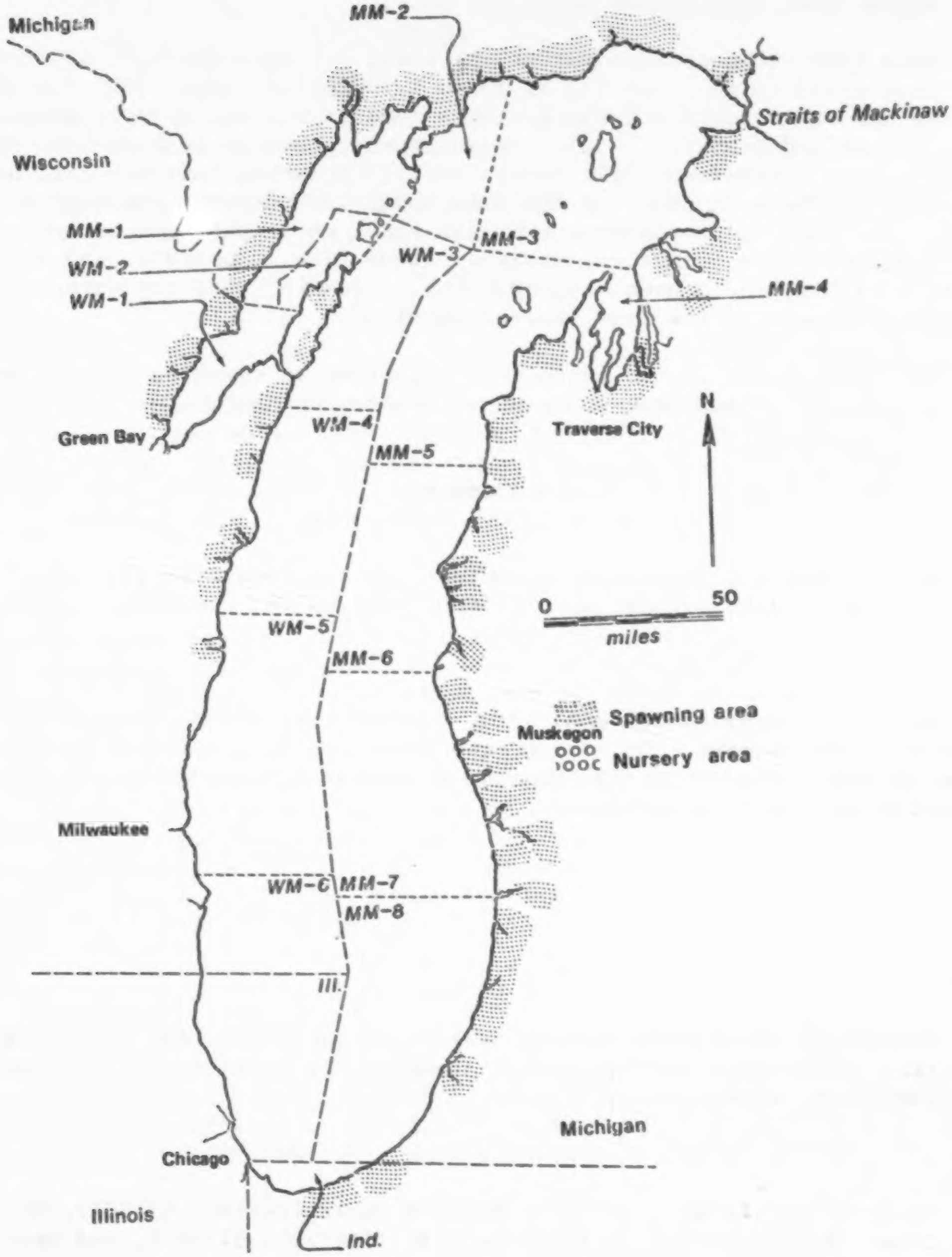
Almost 100 species of fish have been recorded as residents in Lake Michigan (Emery 1976; Koch, pers. comm. 1979; MWRC 1975; Wells, pers. comm. 1979). This volume describes the reproductive habitat used by the 64 species for which information was available. Fifty-two species treated in this volume were native to the lake. Most of these 52 native species spawned (or spawn) in tributaries, reef area, or in shallow, protected waters of the lake. Only the lake trout, seven species of ciscoes, and the fourhorn sculpin, utilized the deep offshore waters for spawning. Six of these deepwater spawners, the blackfin cisco, longjaw cisco, shortjaw cisco, shortnose cisco, deepwater cisco, and kiyi are now believed to be extinct in Lake Michigan. Only the lake trout spawned in the shallow nearshore waters and also the deeper offshore waters.

The 12 exotic species treated in this volume were introduced by man or immigrated to the lake during the period of record, from populations established elsewhere in the Great Lakes drainage. Six of these are salmonids which spawn in tributaries; the other six exotic species spawn in tributaries and also in protected nearshore waters in some areas.

Information on nursery areas used by the 64 species treated in this volume is fragmentary, but as would be expected, it suggests that tributaries and nearshore waters are important as nursery areas, at least for the earliest life stages. Dispersal from spawning areas is rapid for some species which have small, pelagic larvae, whereas the juveniles of some salmonids that spawn in tributaries may remain in or near spawning areas in those tributaries for as many as three years before entering the lake and dispersing.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Each species narrative presents the available information systematically by statistical fishing district (Smith et al. 1961) beginning with district WM-1 and ending with district MM-8. Within each district the presentation proceeds systematically from one end of the district to the other, by shoreline segment and adjacent littoral and offshore water areas. For each referenced location within a district, the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

SEA LAMPREY


Michigan
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Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Green Bay
WM-4
MM-5
Traverse City
N
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

The first reported capture of a sea lamprey in Lake Michigan occurred near Milwaukee in March 1936. In June 1936, a male apparently on a spawning run was captured at Elk Rapids, and later that year two immature adults were captured. The sea lamprey may have been established in the lake since about 1932 (Hubbs and Pope 1937).

Many Lake Michigan tributaries are ideal for reproduction; ammocoetes have been found in at least 112 of these tributaries (Dees 1980) and also in bays and in the lake off river mouths (Hansen and Hayne 1962; Morman 1979; Wagner and Stauffer 1962). Spawning runs usually peak in late May or early June (Fisherman 1947; Morman 1979). Spawning runs are rare or absent along the west shore of the lake south of Green Bay (Morman et al. 1980). Sea lamprey populations are also small in tributaries of southern Lake Michigan where pollution, unstable steam flow, substrate, and water temperature limit or prevent reproduction. Spawning runs are extensive in the northern part of the lake (Morman 1979).

The tributaries listed below are classified as spawning streams based on the presence of ammocoetes, spawning adults, or both.

Wisconsin

The following streams have spawning runs (Applegate et al. 1952; FWS 1979b,c; GLFC 1973b; Torblaa and Westman 1980, unless otherwise noted).

WM-1

Menominee River (45°06', 87°35'), Little River (45°03', 87°38'), Peshtigo River (44°58', 87°39'), Oconto River (44°54', 87°50'), Pensaukee River (44°49', 87°54'), Little Suamico River (44°42', 87°59'), and Big Suamico River (44°38', 88°00').

WM-2

Ephraim River (45°09', 87°10').

WM-3

Hibbard Creek (44°59', 87°10), Whitefish Bay Creek (44°55', 87°13'), Shivering Sands Creek (44°52', 87°14'), Lilly Bay Creek (44°51', 87°16'), and Bear Creek (44°42', 87°21').

WM-4

Stony Creek (44°40', 87°23'), Ahnapee River (44°36', 87°26'), Three Mile Creek (44°34', 87°27'), Kewaunee River (44°28', 87°30'), and East Twin River (44°09', 87°34').

Manitowoc River (44°05', 87°39') (Norden, pers. comm. 1980).

Pine Creek (43°59', 87°42') and Fischer Creek (43°56', 87°43').

WM-5

Sheboygan River (43°45', 87°42').

Indiana

Spawning occurs in the following tributaries (FWS 1979b; GLFC 1975; Morman 1979; Torblaa and Westman 1980).

Burns Waterway (41°38', 87°10'), Donns Creek (41°40', 87°04'), Trail Creek (41°44', 86°54'), and State Creek (41°46', 86°49').

Michigan

The following tributaries have spawning runs (Applegate 1950; Bails et al. 1971; Braem and Rugen 1976; Erkkila et al. 1956; FWS 1979b,c; GLFC 1973b, 1975; Morman 1979; North Woods Call 1979g; Price and Kelly 1976; Smith 1971; Smith and Braem 1976; Smith and McLain 1962; Stauffer 1961; Torblaa and Westman 1980; Wagner and Stauffer 1962).

MM-1

Springer Creek (45°11', 87°34'), Beattie Creek (45°14', 87°31'), Bailey Creek (45°15', 87°29'), Johnson Creek (45°16', 87°28'), Rochereau Creek (45°18', 87°26'), Arthur Bay Creek (45°19', 87°26'), Sugar Creek (45°22', 87°23'), Cedar River (45°24', 87°21'), Bark River (45°34', 87°14'), Sunny Brook (45°40', 87°10'), Ford River (45°40', 87°08'), Portage Creek (45°42', 87°06'), Days River (45‘54', 86°59'), Tacoosh River (45°55', 86°58'), Rapid River (45°55', 86°58'), Whitefish River (45°55', 86°57'), Black George (Hock) Creek (45°53', 86°57'), Squaw Creek (45°48', 86°59'), Ogontz River (45°52', 86°46'), Sturgeon River (45°50', 86°40'), Fishdam River (45°54', 86°35'), Little Fishdam River (45°54', 86°34'), and Valentine Creek (45°50', 86°32').

MM-2

Poodle Pete Creek (45°47', 86°26'), Parent Creek (45°48', 86°25'), Bursaw Creek (45°50', 86°20'), Deadhorse and Snyder Creeks (45°52', 86°20'), Johnson Creek (45°53', 86°20'), Thompson Creek (45°54', 86°19'), Southtown Creek (45°56', 86°16'), Manistique River (45°57', 86°15'), Marblehead Creek (45°58', 86°07'), and Gulliver Lake Outlet (45°58', 86°03').

MM-3

Bulldog Creek (45°57', 85°55'), Milakokia River (45°58', 85°54'), Swan Creek (45°59', 85'49'), Hudson Creek (45°58', 85°42'), Point Patterson Creek (45°58', 85°39'), Catarac River (45°59', 85°39'), Crow

River (46°02', 85°36'), Rock River (46°05', 85°32'), Mille Coquins River (46°06', 85°29'), Mile Creek (46°06', 85°26'), Black River (46°06', 80°21'), Sucker Creek (46°05', 85°19'), Hog Island Creek (46°04', 85°17'), Davenport Creek (46°04', 85°16'), Paquin Creek (46°04', 85°13'), Brevoort River (45°57', 84°56'), Carp Lake River (45°45', 84°50'), Big Stone Creek (45°45', 84°54'), Big Sucker Creek (45°44', 84°56'), Wycamp Creek (45°39', 85°01'), Bear River (45°23', 84°58'), Boyne River (45°13', 85°01'), Porter Creek (45°13', 85°04'), Jordan River (45°09', 85°08'), Horton Creek (45°17', 85°05'), Monroe Creek (45°11', 85°10'), Loeb Creek (45°17', 85°14'), and McGeach Creek (45°18', 85°19').

MM-4

Antrim Creek (45°10', 85°23'), Elk River (44°54', 85°25'), Yuba Creek (44°49', 85°28'), Acme Creek (44°46', 85°30'), Mitchell Creek (44°45', 85°34'), and Boardman River (44°46', 85°37).

MM-5

Shalda Creek (44°57", 85°53'), Crystal River (44°55', 85°58'), Platte River (44°44', 86°09'), Betsie River (44°37', 86°13'), and Bar (Bowens) Creek (44°29', 86°14').

MM-6

Big (44°15', 86°18') and Little (44°13', 86°16') Manistee Rivers, Gurney Creek (44°08', 86°25'), Big Sable River (44°02', 86°30'), Lincoln River (43°59', 86°28'), Pere Marquette River (43°56', 86°26'), Bass Lake Outlet (43°50', 86°26'), and Pentwater River (43°46', 86°24').

MM-7

Stony Creek (43°34', 86°30'), Flower Creek (43°28', 86°28'), White River (43°25', 86°21'), Duck Creek (43°21', 86°25'), Big Bear Creek (43°15', 86°18'), Muskegon River (43°15', 86°15'), Black Creek (43°08', 86°17'), Grand River (43°03', 86°15'), Pigeon River (42°54', 86°12'), and Pine Creek (42°48', 86°09').

MM-8

Gibson Creek (42°43', 86°13'), Kalamazoo River (42°40', 86°13'), Allegan 3 Creek (42°36', 86°13'), Allegan 4 Creek (42°35', 86°13'), Allegan 5 Creek (42°34', 86°14'), Black River (42°24', 86°17'), Brandywine Creek (42°19', 86°19'), Rogers Creek (42°15', 86°21'), St. Joseph River (42°07', 86°29'), and Paw Paw Rivers (42°07, 86°28'), and Galien River (41°48', 86°45').

LAKE STURGEON

Historically, lake sturgeon spawned in many tributaries of Lake Michigan. Populations were reduced by the degradation of spawning grounds in these rivers and near river mouths (Wells and McLain 1973). In Green Bay (45°05', 87°25'), spawning runs generally occur in April and May immediately after the walleye runs (Copes, pers. comm. 1979). For many years, most streams in Green Bay were too polluted to support runs (Bertrand et al. 1976).

Wisconsin

WM-1

Menominee River (45°06', 87°35'). This river, which forms the boundary between Wisconsin and Michigan, supported large sturgeon spawning runs prior to the 1900s (Belonger, pers. comm. 1979; Binkowski, pers. comm. 1979) and now may be a potential spawning site (Kernen, pers. comm. 1979). Lake sturgeon now migrate up the Menominee River (Copes, pers. comm. 1979).

Peshtigo (44°58', 87°39') and Oconto (44°54', 87°50') Rivers. These are potential spawning grounds (Kernen, pers. comm. 1979). The removal of dams on the rivers would increase access to prime spawning grounds (GLFC 1979b).

Long Tail Point (44°35', 87°59')--Grassy Island (44°33', 87°59'). A commercial fisherman reported that this is a spawning area for lake sturgeon (Coberly and Horrall 1980b).

Fox River (44°32', 88°00'). This is an historical spawning ground (Copes, pers. comm. 1979; Kernen, pers. comm. 1979). Lake sturgeon are presently found in the river (Kernen, pers. comm. 1979), and spawning occurs there (Copes, pers. comm. 1979).

Illinois

In southern Lake Michigan, lake sturgeon congregated at river mouths and near shore in June to spawn (Kirsch and Fordice 1889; Milner 1874a).

South Chicago (41°46', 87°33'--41°41', 87°29'). Lake spawning historically occurred here (Harkness and Dymond 1961). In 1871, many spent fish and one gravid individual were taken at the mouth of the Calumet River (41°44', 87°32') in a single seine haul on July 1 (Milner 1874a).

Michigan

MM-3

Fox Island (probably South Fox Island, 45°25', 85°51'). In 1890, ripe male and female lake sturgeon were collected at Fox Island between May 26 and June 14 (Leach and Borodin 1920).

MM-4

Grand Traverse Bay (45°05', 85°30'). Spawning runs formerly entered many of the spring-fed streams and rivers in this area; dams built in the mid-1800s at Elk Rapids (44°54', 85°25') and on Kid's Creek (44°46', 85°38') blocked spawning runs on those streams (Price and Kelly 1976).

MM-6

Ludington (43°57', 86°28'). Spawning was observed at Point Sable (probably Big Sable Point, 44°03', 86°31') (Harkness and Dymond 1961). Lake sturgeon spawned in the lake proper on clay banks approximately 8 mi N of Pentwater (43°47', 86°26') (MSBFC 1890).

MM-8

Saugatuck (42°40', 86°12'). Lake spawning occurred here (Harkness and Dymond 1961). The Kalamazoo River (42°40', 86°13') upstream to the first dam was a favorite spawning ground (Milner 1874a).

Ganges (42°35', 86°13'). Since 1934, spawning has occurred along 2 mi of shoreline (42°36', 86°14'--42°34', 86°14') here; in 1978, spawning occurred over gravel bottom in June (Organ et al. 1978).

South Haven (42°24', 86°17'). In the late 1800s, lake sturgeon "favored" the area near here, and the spawning grounds were believed to be not far away (Smith and Snell 1891).

St. Joseph (42°07', 86°29') and Galien (41°48', 86°45') rivers. Lake sturgeon spawned in these rivers, but it is not known if these were lake-run fish (Organ et al. 1978). Historically the St. Joseph River was a favorite spawning ground (MSBFC 1893).

New Buffalo (41°48', 86°45'). Since 1934, lake sturgeon have spawned in an area (41°49', 86°43'), approximately 1-2 mi N of New Buffalo over a sandy bottom with some rock, at water depths of 6 ft or less (Organ et al. 1978).

Pier Cove (location unknown). In 1871, schools of sturgeon, presumably seeking a river in which to spawn, were present in shallow water here on June 11 (Milner 1874a).

BOWFIN

Bowfins are residents of the protected bays, river mouths, and marshes of Lake Michigan and also spawn in these areas. Green Bay (45°05', 87°25') is a major spawning area for bowfins. The following locations in Lake Michigan support self-sustaining populations and are probably both spawning and nursery areas.

Wisconsin

WM-1

Menominee River (45°06', 87°35'). The mouth of the river is a spawning area (Belonger, pers. comm. 1979).

Peshtigo River (44°58', 87°39') and Oconto River (44°54', 87°50'). The lower areas of both rivers are probably spawning and nursery areas (Belonger, pers. comm. 1979).

Little Sturgeon Bay (44°50', 87°33') (Kernen, pers. comm. 1979).

Sturgeon Bay (44°53', 87°24')--Sawyer Harbor (44°53', 87°26') (Kernen 1972, pers. comm. 1979).

WM-3

Rowley Bay (45°13', 87°01')--Mink River (45°14', 87°02'). Spawning has been observed in the marshy portions of the Mink River estuary (Kernen, pers. comm. 1979).

Michigan

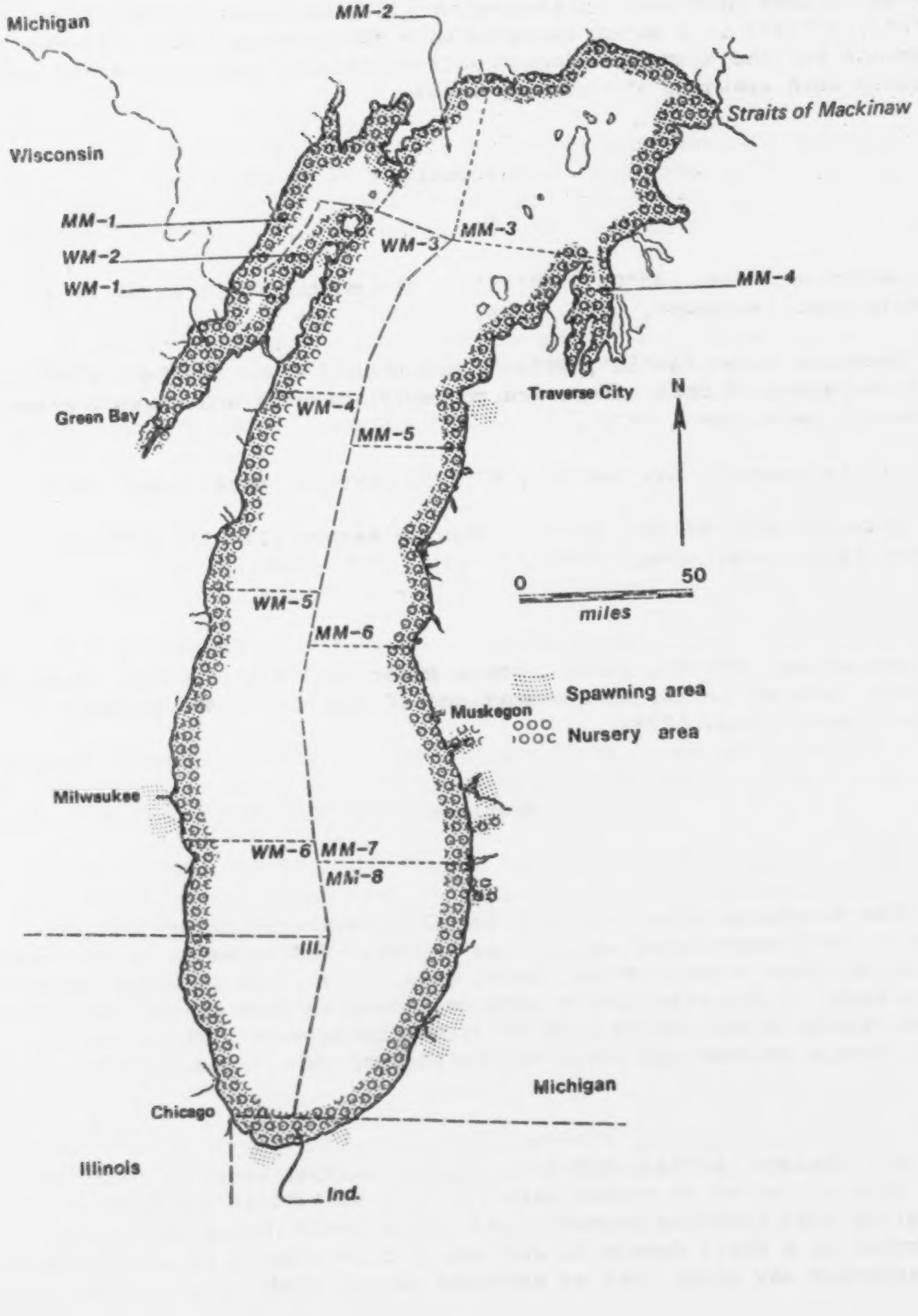
MM-6

Pere Marquette River (43°56', 86°26')--Pentwater River (43°46', 86°24'). Self-sustaining populations are believed to exist in the lower reaches of these rivers (Brazo, pers. comm. 1979), and spawning probably occurs here. A few ripe adults were collected in June at the Ludington Pumped Storage Plant (43°54', 86°27'), but these were believed to be strays moving between the river mouths (Brazo, pers. comm. 1979).

MM-7

Port Sheldon (42°54', 86°13'). Bowfin larvae, about 0.2-1.0 in. long, were collected in Pigeon Lake (42°54', 86°12') in early June, indicating that spawning probably took place there during May. The collection of a spent female in July and a ripe male in October suggests that spawning may occur over an extended period (Jude et al. 1979a).

ALEWIFE


Michigan
MM-2
Wisconsin
Straits of Mackinaw
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Green Bay
Traverse City
N
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

The alewife presumably entered Lake Michigan from Lake Huron. The first recorded capture of an alewife in Lake Michigan occurred near South Manitou Island, Michigan, on May 5, 1949 (Miller 1957). Schools of young-of-the-year (YOY) found in southern Green Bay in 1953 presented the first indication of successful spawning; the first substantial spawning run occurred in Green Bay in 1956 (Joeris and Karvelis 1962; Miller 1957).

Alewives migrate in large schools from deeper water to inshore areas beginning about the second week in April. The migration begins earlier in the southern portion of the lake than in the northern portion and earlier along the west shore than along the east shore. Spawning has been reported from mid-May into August (Brown 1972; Buss and Warner 1972; Hlavek and Norden 1978; Organ et al. 1978; Reigle 1969a, 1969c; Wagner 1972; Walburg 1973), with a peak in July (Hlavek and Norden 1978; Walburg 1973).

Alewives may spawn along the entire shoreline of Lake Michigan (Brown, pers. comm. 1979; Moore, pers. comm. 1979; Wells 1979). They spawn inshore, mainly in stream mouths and protected areas, including harbors and bays, and tend to concentrate near breakwalls (Brown 1972, pers. comm. 1979; Buss and Warner 1972; USBCF 1965; USDI 1966; Walburg 1973). Alewives also enter tributaries, especially in the southern part of the lake (Edsall 1964, Moffett 1966a), and spawning can occur far upstream in rivers not blocked by dams (Brown, pers. comm. 1979).

Alewives spawn in the northwest portion of Lake Michigan from late spring to late July in 6-20 ft of water over sand and rock (Organ et al. 1978). Spawning is common in tributary streams and in nearshore sheltered areas of Green Bay; when the water is warm enough, spawning occasionally occurs along unprotected shoreline (CDM/Limnetics 1976c; GLFL 1970; Walburg 1973). Most, if not all, of the inshore waters of Green Bay are potential spawning areas (Brown, pers. comm. 1979; Moore, pers. comm. 1979; Wells, pers. comm. 1979). Spawning begins in June or early July and continues through early August based on seasonal trends in the commercial catch. Alewives reach peak abundance in Green Bay during early-mid July (Bertrand et al. 1976; Brown, pers. comm. 1979; GLFC 1976; Joeris and Karvelis 1962; Reigle 1969b). After spawning, adults leave Green Bay (Joeris and Karvelis 1962); many that have apparently returned to the lake are often found off Sturgeon Bay (44°53', 87°24') at depths of 60-420 ft (Brown, pers. comm. 1980). Spawning also occurs everywhere along the shoreline in the northeastern portion of the lake in 15-30 ft of water, wherever there is sand (Organ et al. 1978). Alewives spawn successfully along the entire shoreline in the southern two-thirds of the lake (CDM/Limnetics 1976c). Generally, most sources agree that spawning takes place along the entire shoreline of the lake over sand, rock, and gravel in waters 2-30 ft deep at water temperatures of 55-70°F (Moffett 1966a; Organ et al. 1978; Reigle 1969c).

The entire nearshore area inside the 30 ft depth contour along the east shore of Lake Michigan is heavily used as a nursery ground, at least as far north as Frankfort (44°38', 86°14'). Alewife nursery areas are much less abundant on the western shore. The abundance of adults on the western shoreline suggests that heavy spawning occurs there, but fry may be swept away from shore during upwellings. In Green Bay, YOY are first collected in trawls in early August, and they remain in Green Bay at least until the ice forms (Joeris and Karvelis 1962). In general, nursery grounds include all nearshore areas of the lake for early stages and all pelagic waters for later YOY stages (Wells 1973, pers. comm. 1979).

Alewife larvae tend to concentrate in the upper 6-10 ft of the water column but occur as deep as 30 ft (Wells 1974). In late August 1965, YOY were observed in the epilimnion of southern Lake Michigan at temperatures of about 68°F (Wells 1980). Eggs and young have been known to thrive in warm bays and rivers, even those that are heavily contaminated with wastes (Smith 1968). Both YOY and adults move to deeper water in fall (Brown 1972; USDI 1966; Walburg 1973).

Wisconsin

WM-1

Marinette (45°05', 87°36'), Oconto (44°53', 87°52'), and Suamico (44°38', 88°03'). In 1978, YOY were found here in late August and September (Belonger 1979).

Duck Creek (44°34', 88°02'). Schools of YOY found in carp-holding ponds near here in October 1953 were the first evidence of spawning success in Lake Michigan (Joeris and Karvelis 1962; Miller 1957).

Fox River (44°32', 88°00). In 1975-76, impingement of adults at the Pulliam Power Plant (44°32', 88°00') peaked in June as adults migrated inshore. Eggs were found in the river and in the bay off the plant during June to August. Larvae were first collected July 2 in the river and July 30 in Green Bay (NALCO, undated a).

WM-2

Gills Rock (45°17', 87°02'). Alewives spawn over sand, rubble, or large boulders in water 2-30 ft deep (Joeris and Karvelis 1962).

WM-3

Door Peninsula (45°05', 87°10'). Spawning occurs primarily in June in the waters along the northern portion of the peninsula. Alewives spawn in all the bays at the northern tip of the peninsula, including North Bay (45°09', 87°04'), Moonlight Bay (45°05', 87°05'), Baileys Harbor (45°03', 87°07'), Rowley Bay (45°13', 87°01'), and in the marshy areas of the Mink River estuary (45°14', 87°02') (Frederick, pers. comm. 1979).

Sturgeon Bay Ship Canal (44°48', 87°19'). Alewives probably move up the Ship Canal to spawn in June and July. During the 1960s and early 1970s, large concentrations of adults were observed in the lake proper off the mouth of the canal in late May (Brown, pers. comm. 1979).

WM-4

Kewaunee Power Plant (44°21', 87°32'). Alewives spawn along much of the beach near the plant (USAEC 1972e). The substrate at the intake area and 1 mi N of the plant is rock and rubble over sand or clay (Ind. Bio-Test 1972). Alewives in spawning condition have been collected in large numbers during June and July at the intake and north and south of the intake at the 10 and 20 ft depth contours when the water temperature was about 49-50°F (LaJeone 1976). Adults moved inshore in spring, and the maximum impingement of adults occurred in June. After spawning, adults gradually disperse to deep water in late summer and early fall (NALCO, undated b). Eggs were entrained at the plant from late June to mid-August with peak entrainment in mid-July; alewife eggs were about 70% of the total number of eggs entrained (NALCO, undated a). Alewife eggs were also collected at all sampling stations located within 1/2 mi N and 2 mi S of the plant at the 10 and 20 ft depth contours; the largest number of eggs were collected near the plant water intake (LaJeone 1976). Larvae about 0.3-0.8 in. long have been entrained in mid-July and August (NALCO, undated a). In September 1975, many YOY were collected with minnow seines 2 mi S of the plant offshore of Two Creeks (44°18', 87°33') (LaJeone 1976).

Point Beach Power Plant (44°17', 87°32'). Alewife eggs and larvae are more abundant here than those of most other species (Wis. Elec. Power, undated). Alewives migrate inshore to spawn during April, May, and June (Limnetics 1974; Prepejchal, Romberg, and Spigarelli 1974; Wis. Elec. Power 1975a; Wis. Elec. Power and Wis.-Mich. Power, undated a,c). During June, hundreds of thousands of alewives move into the intake and discharge areas of the plant; by the end of July few remain in the area (Limnetics 1974; Reed 1972; Romberg and Spigarelli 1973; Wis. Elec. Power, undated). Ripe adults are impinged from June through mid-August (Wis. Elec. Power 1976c). Alewife eggs are present in the vicinity of the power plant during March to August. Eggs are collected in the discharge and intake areas as early as June 3, and peak abundance occurred in July when the water temperature reached 45-48°F (Limnetics 1974; Wis. Elec. Power 1975a, 1976c; Wis. Elec. Power and Wis.-Mich. Power, undated a,b,c). Fry were collected in several areas surrounding the power plant during August through October over hard clay, scattered rock, silt, and shifting sand (Limnetics 1974; Wis. Elec. Power 1975a). Young-of-the-year were collected in shore seines, and schools were observed moving into the discharge area in September and October (Romberg and Spigarelli 1973; Wis. Elec. Power, undated). Fry migrated from the nearshore zone by October (Wis. Elec. Power and Wis.-Mich. Power, undated b).

East Twin River (44°09', 87°34'). Alewives are abundant in the lower river during the spawning season (Weber, Desparte, and Threinen 1968).

Manitowoc (44°05', 87°39'). Alewife eggs were collected at the Manitowoc Generating Plant (44°05', 87°39') from mid-June to early September. The majority of entrained eggs were taken in July. No larvae were collected in the area, but juveniles were observed swarming near shore in late summer (CDM/Limnetics 1976a).

WM-5

Haven (43°51', 87°44'). In 1973-74, ripe adults were collected in the area from May through September (Ind. Bio-Test 1977; Wis. Elec. Power et al. 1979b). Based on observations made in July and August, adults appeared to be spawning; by September, many adults were spent (Ind. Bio-Test 1977; Wis. Elec. Power et al. 1979b). Spawning occurs near shore over hard clay, cobble-size rock, and scattered boulders (LaJeone, pers. comm. 1979). Eggs were collected from early July through August when water temperatures were about 46-55°F (Ind. Bio-Test 1977; Wis. Elec. Power et al. 1979a). Eggs were collected at the surface, the 15 ft depth stratum, and on the bottom at the 20 ft contour, throughout an area that extended 2 mi N and 2 mi S of the plant (Ind. Bio-Test 1977); the greatest number of eggs were collected nearshore at the 10 ft depth contour (Wis. Elec. Power et al. 1979a, 1979b). Alewife larvae were collected during July to September (Wis. Elec. Power et al. 1979a,b).

Sheboygan (43°45', 87°42'). Alewives spawned successfully in the vicinity of the Edgewater Power Plant (43°43', 87°42'). In 1975-78, ripe or ripening fish were impinged at the plant during June and July; peak impingement occurred in mid-June. Eggs were collected in the lake and entrained from June to August; the first eggs were taken when the water temperature reached about 44°F. Larvae were found beginning in late August (Swanson Environ. 1976, 1979).

Port Washington (43°23', 87°52'). In 1975, adults were impinged at the Port Washington Power Plant (43°23', 87°52'), from early March to June; almost 60% of the total impingement occurred between late May and early June. Eggs and larvae were entrained at the plant during July to August and July to September respectively (Wis. Elec. Power 1976e).

Milwaukee (43°02', 87°54'). Alewives migrate into shallow waters in the Milwaukee area during late April and early May and begin to leave at the end of August after spawning (Binkowski, pers. comm. 1979; Janssen, pers. comm. 1979; Limnetics 1974; Norden 1967a; Shaefer 1975; Wis. Elec. Power 1975b). In 1979, adults were observed near shore in May, ripe adults were collected in July, and spawning occurred from mid-July to mid-August. Spawning usually occurs in the area from June 1 through August. Alewives spawn over a period of 4-6 weeks, when temperatures are about 59-64°F (Binkowski, pers. comm. 1979). Alewives spawn in large numbers in the Milwaukee Harbor area (Binkowski, pers. comm. 1979; Janssen, pers. comm. 1979; Norden, pers. comm. 1979). Gravid females, newly fertilized eggs, and newly hatched larvae were collected in the harbor in late July and August when water temperatures were about 63-70°F (Hlavek and Norden 1978; Norden, pers. comm. 1979). In 1965, spawning peaked during the first 2 weeks of July. The collection of larvae indicated that spawning may have occurred from late June to August in 1965 and from late June to October in 1966 and 1967 (Norden 1967a, 1968). Heavy concentrations of spawning alewives were observed along the breakwalls at the Inner Harbor (43°01', 87°53'), the Milwaukee Yacht Club (43°03', 87°53'), and at McKinley Beach (43°03', 87°53') (Binkowski, pers. comm. 1979). In 1965, eggs were found in the harbor area consistently from the end of July to the end of August (Norden 1967a). Eggs and larvae were collected along the edge of the seawall and at the surface as far as 1 mi offshore. Most larvae more than 0.8 in. long were seined about 1 mi N of the harbor at the water purification plant (43°04', 87°52') (Norden 1967b).

Runs enter the Milwaukee River (43°02', 87°54') from late May to early August (Binkowski, pers. comm. 1979; Poff and Threinen 1964; Wis. Elec. Power 1976b). Ripe alewives were impinged at the Commerce Street Power Plant (43°02', 87°54') from early June to early August, and eggs were collected in the area in June (Wis. Elec. Power 1976b). Ripe adults were found in the area and were impinged at the Lakeside Power Plant (42°58', 87°51') from late May to mid-August; peak abundance occurred in late June. Eggs were entrained during July (Limnetics 1974; Wis. Elec. Power 1976a).

Young-of-the-year may be distributed all along the shore in the Milwaukee area; they were found in large numbers at the South Shore Yacht Club boat launch (43°00', 87°53') (Binkowski, pers. comm. 1979). In the Milwaukee Harbor area, newly hatched larvae were collected at the end of July and August when water temperatures were about 64-70°F; YOY were taken as late as October, if the water temperature remained high enough (Norden, pers. comm. 1979; Norden 1967a). Young-of-the-year were found off the Lakeside Power Plant, often in less than 18 ft of water, from July to October (Limnetics 1974; Wis. Elec. Power 1975c). In 1968, YOY alewives were collected in shore seines to depths of 3-4 ft in September and October (Brown and Norden 1970). In late June, fry were common in the nearshore zone from Waukegan (42°22', 87°50') to Milwaukee, but were scarce north of Milwaukee (Harris and Eschmeyer 1975). Young-of-the-year alewives stayed inshore in the beach zone, and concentrated around jetties and breakwaters, except when upwellings lowered the inshore temperatures; then they were often found offshore in the epilimnion at depths of 30-100 ft (Binkowski, pers. comm. 1979). Young-of-the-year were common at the surface, when temperatures were greater than about 70°F (Harris and Eschmeyer). Young-of-the-year alewives were collected at Bradford Beach (43°04', 87°52'), McKinley Beach, McKinley Beach jetties, and the South Shore Yacht Club marina. Temperatures at the South Shore Yacht Club when YOY were collected were about 59-72°F; the site has a sand and gravel bottom with submergent vascular plants (Binkowski, pers. comm. 1979).

Oak Creek (42°54', 87°51'). Alewives enter Oak Creek in the spring (Binkowski, pers. comm. 1979; Janssen, pers. comm. 1979). The intake channel of the Oak Creek Power Plant (42°51', 87°50'), which has a substrate of sand and coarse detritus, is a favorable spawning area. In 1972-76, inshore movement began in March, and adults were impinged from April to July. Eggs were collected in June and July, and larvae and YOY were taken from July to September (Limnetics 1974; Wis. Elec. Power 1975b, 1976d).

WM-6

Racine County (42°49', 87°49'--42°40', 87°48'). Many alewives enter shallow water and streams to spawn (Poff and Threinen 1961a).

Illinois

Alewives spawn along the entire Illinois shoreline (42°29', 87°48'--41°43', 87°32') out to a depth of 50 ft, from mid-May to mid-July (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). This entire area appears to be a spawning and nursery ground (Commonw. Edison 1976; Ind. Bio-Test 1975b; Raney 1972). Adults in spawning condition moved inshore from March to June when the water temperature reached about 43-50°F. Maximum impingement of adults at the Zion (42°27', 87°48') and Waukegan (42°23', 87°49') generating stations occurred in May and June (CMD/Limnetics 1977; Cima 1977; Cima et al. 1976; Cochran undated, 1975, 1976; Cochran and Kitchel 1976; Johnson and Muench undated; Kitchel and Otto 1974, 1976; Orpet and Cochran 1976; Otto 1975; Prepejchal, Romberg, and Spigarelli 1974). Spawning begins in June, peaks in July when the water temperature reaches about 56-64°F, and continues through the end of August (Cima 1977; Cima et al. 1976; Cochran undated; Cochran and Cima 1974; Ind. Bio-Test 1975a,b; Otto 1975). Eggs were entrained from May to August at the stations. Egg densities increase rapidly in late June and peak in July. Eggs have been collected throughout the entire area; most eggs were collected at depths of 40 ft or less, but some were found at depths as great as 60 ft. (CDM/Limnetics 1977; Cima 1977; Cima et al. 1976; Cochran undated; Cochran and Cima 1974; Ind. Bio-Test 1975b; Muench, pers. comm. 1979; Otto 1975). Spawning was observed in Waukegan Harbor (42°22', 87°49') (Brown, pers. comm. 1979) and in the intake bay of the Waukegan Generating Station (Otto 1975). Larvae were entrained at the Zion and Waukegan generating stations and were abundant throughout the area during June to October (Cochran and Cima 1974). Larvae were collected in water 10 to 60 ft deep, but most were taken at depths of 30 ft or less (CDM/Limnetics 1977; Cima and Cochran undated; Cima et al. 1976; Cochran undated; Ind. Bio-Test 1975b; Otto 1975). Generally, larvae were collected from June to August; peak abundance occurred in July (Cima et al. 1976; Cochran and Cima 1974, Otto 1975). Many YOY were seined from the intake pond and discharge canal of the Waukegan Generating Station (Otto et al. 1976).

Chicago (41°53', 87°37'). In 1966, adults were collected from May 26 to June 13 during the spawning run (Brown 1968). Spawning was observed along shore from Evanston (42°03', 87°40') to Chicago during mid- to late July and sometimes into August. Fry remained in the area about 2 weeks (Janssen, pers. comm. 1979).

Indiana

Alewives spawn all along the Indiana shoreline (41°43', 87°32'--41°46', 86°49'), including harbor areas, to water depths of about 35 ft (Koch, pers. comm. 1979; McComish, pers. comm. 1979). The spawning migration begins in March and April (CDM/Limnetics 1977; Koch, pers. comm. 1979; Krueger 1976; McComish, pers. comm. 1979; Morgan 1978a; NALCO 1976a,c; Tex. Instrum. 1975b). Eggs were collected from May through July; egg densities were highest in nearshore waters, usually at depths of about 30 ft or less (McComish, pers. comm. 1979). Spawning is usually completed by July; adults begin moving offshore in late July and August (Morgan 1978a; Koch, pers. comm. 1979; McComish, pers. comm. 1979). Young-of-the-year were collected all along the Indiana shoreline, usually out to a depth of about 33 ft, from July to September. Young-of-the-year were concentrated nearshore in July and August, and the entire shore zone is a nursery area (McComish, pers. comm. 1979). When the water cools in September, YOY move offshore (Koch, pers. comm. 1979; McComish, pers. comm. 1979).

Hammond (41°40', 87°30'). Alewives are believed to spawn successfully near the Stateline Generating Station (41°42', 87°31'). In 1975-76, alewife eggs and larvae were 99% and 90% respectively of the total number of fish and larvae entrained at the plant and collected in the area from May to August. Eggs were generally most abundant inshore in late June, and larvae were most abundant in late June and early July (NALCO 1976c).

Gary (41°37', 87°20'). Adults move inshore and enter streams in the area in April. At the Mitchell Power Station (41°37', 87°22'), most adults were collected and impinged in May and June. Eggs were entrained at the plant from May to August and larvae from May to September. Spawning may have occurred in the intake and discharge canals of the plant (CDM/Limnetics 1977, Krueger 1976, NALCO 1976a).

Bailly Generating Station (41°39', 87°07'). Spawning occurs in the area from May to mid-August, and reaches a peak during June and July, when most adults are found in the area and impingement at the plant is highest. Spawning was observed in late May and early June in the discharge canal. Eggs were collected throughout the area from May to September, and the highest densities occurred near the plant discharge. Prolarvae and postlarvae were present from May to October (Tex. Instrum. 1975b, 1976a,c, 1977b,c, 1979a).

Michigan City (41°43', 86°54'). Adults are most abundant in the area during April to June, during the spawning period. The inshore movement begins in March; adults move offshore in July (Morgan 1978a). Spawning was observed in the discharge canal of the Michigan City Generating Station (41°43', 86°54') (Morgan 1978a,b), in Michigan City Harbor, and at the mouth of Trail Creek (41°44', 86°54') (Brown, pers. comm. 1979). The area from Michigan City east to the Michigan state line (41°46', 86°49') is an important nursery area; the densities of YOY are higher here than farther west (McComish, pers. comm. 1979).

Michigan

MM-1

Little Bay de Noc (45°45', 87°00'). Adults enter the bay by the end of May and are abundant in late spring and summer (FWS 1979d; Wagner 1971, 1973; Wagner and Stauffer 1969). Spawning has occurred since the 1950s from Gladstone (45°51', 87°00') south along the shore for 2-3 mi over a rocky substrate to a depth of about 6 ft (Organ et al. 1978). Spawning has also been observed at Escanaba (45°45', 87°04') in a slightly protected area near shore, over mud, sand, and organic debris in water 2-4 ft deep (Joeris and Karvelis 1962). Hatching probably occurs in the bay from early June through late July. Alewife larvae have been observed in dense schools on the surface of the bay. Prolarvae and postlarvae have been taken from mid-June through September with a peak in mid-August. Larvae were distributed throughout the surface waters of the bay in July and August, but greater numbers were collected at stations nearest shore (Wagner 1971, 1973; Wagner and Stauffer 1969). Young-of-the-year, 0.2-2.8 in. long, are abundant from July through September (Peck 1974, Wagner 1972).

Ford River (45°40', 87°08')--Bark River (45°34', 87°14'). In 1978-79, alewife eggs were collected from mid-June to mid-August along shore at the 5 and 10 ft depth contours. Larvae were collected with shore seines and trawls from June to October (Wis. Elec. Power, unpubl. data).

Arthur Bay (45°19', 87°26'). Since 1963, alewives have spawned over rock in 6-18 ft of water and over sand and rock to depths of 36 ft. The spawning area (45°20', 87°24'--45°17', 87°27') extends about 2 mi N and S of the town of Arthur Bay (Organ et al. 1978).

MM-2

Manistique (45°57', 86°15'). In 1978, adults in spawning condition were observed at the mouth of Manistique Harbor near the surface in mid- to late June (Owens, pers. comm. 1981). From 1973-80, YOY were collected off Manistique in September to November (FWS, unpubl. data).

MM-3

Brevort (46°01', 85°02'). From 1966-76, spawning was observed in an area (46°01', 85°02') over sand to depths of about 18 ft (Organ et al. 1978).

Big Rock Point (45°22', 85°12'). In 1974-75, two larvae were collected at the Big Rock Power Plant (45°22', 85°12') in late August (Consumers Power 1976e).

MM-5

Frankfort (44°38', 86°14'). Spawning was observed in Betsie Lake (44°38', 86°14') (Brown, pers. comm. 1979).

MM-6

Ludington (43°57', 86°28'). Adults are abundant during the summer in Pere Marquette Lake (43°56', 86°16') (FWS 1979d). The shore area near the Ludington Pumped Storage Plant (43°54', 86°27'), primarily at depths of 15 ft or less, is a spawning and nursery area for alewives. Onshore migration begins in late May or early June, and ripe adults are taken in late June. Ripe and spent fish were collected through August (Brazo, pers. comm. 1979; Liston and Tack 1973). The bottom in this area is composed of sand, gravel, and clay outcroppings with some large rocks (Brazo, pers. comm. 1979). Larvae are collected near the plant from late June to early fall (Brazo, pers. comm. 1979; Liston and Tack 1973; Liston et al. 1978). Swarms of newly hatched larvae were observed at the intake in early August (Liston and Tack 1973). Many YOY are collected at all depths out to 30 ft (Brazo, pers. comm. 1979).

MM-7

Muskegon (43°13', 86°17'). During the 1960s, spawning occurred in an area (43°12', 86°20') 1 mi S of the mouth of Muskegon Lake, from shore out to a depth of about 20 ft over a sandy substrate (Organ et al. 1978). Most adults were impinged at the Cobb Power Plant (43°15', 86°15') on Muskegon Lake during mid-July, and eggs (possibly released by impinged, ripe fish) were entrained in late May and early June. Clupeid larvae were first entrained in mid-July and were 88% of the total larvae entrained (Consumers Power 1976f).

Grand River (43°03', 86°15'). Spawning was observed at the river mouth (Brown, pers. comm. 1979). Young-of-the-year were found off Grand Haven in September (Brandt 1978).

Port Sheldon (42°54', 86°13'). A massive inshore migration to the beach zone occurs; the migration may begin in April, but the main movement occurs in May and June (Jude et al. 1978, 1979a; Heufelder and Klinger, pers. comm. 1979). The number of adult alewives impinged at the Campbell Power Plant (42°55', 86°12') increased dramatically in June and remained high in July; the greatest numbers of adults were also present in the area in late June and early July (Consumers Power 1976b; Jude 1978; Jude et al. 1978). Spawning begins by the first week of June (Jude et al. 1978). Spawning was observed in Pigeon Lake (42°54', 86°12'), in the power plant discharge and intake canals, and almost everywhere along the Lake Michigan shore (Heufelder and Klinger pers. comm. 1979; Jude 1978; Jude et al. 1979a). Spawning is completed by August or September. Adults move out of Pigeon Lake by August and leave the nearshore zone by October (Heufelder and Klinger, pers. comm. 1979; Jude et al. 1978, 1979a). There is extensive egg deposition in the nearshore zone (Jude et al. 1979a). In 1977, densities as high as 512,000 eggs per 1,000m^3 of water were found at beach stations through late July (Jude et al. 1978). In 1974, eggs were entrained from Pigeon Lake during late May to late June (Consumers Power 1976b). Larvae were first collected in early June when water temperatures reached about 55°F, and peak abundance was reached in early July (Consumers Power 1977, Heufelder and Klinger, pers. comm. 1979; Jude 1978; Jude et al. 1978, 1979a). In 1977, densities as high as 9,000 larvae per 1,000m^3 were found at beach stations (Jude et al. 1978). Many were also found in August, and larvae were collected and entrained until October (Consumers Power 1977; Jude et al. 1978, 1979a; Wapora 1979a). The entrainment of larvae 0.2-0.3 in. long in early May suggests that spawning occurs in late April in Pigeon Lake. The larvae that were entrained in large numbers in June may have been spawned in late May in the major rivers in the area (Jude et al. 1979a). Many YOY were collected in seines in the beach zone out to the 10 ft depth contour during July to September. An offshore movement occurs in September and October (Jude et al. 1978, 1979a).

MM-8

Kalamazoo River (42°40', 86°13'). Spawning runs first enter the river in April when water temperatures are below 50°F. Spawning generally occurs from late May through early August and peaks in June and July (Brown 1968, 1970b, 1972; Edsall 1964, 1970a; Wells 1968). In 1963, spawning was observed 2 mi upstream in 10 ft of water in an area with light current (Edsall 1964). Young-of-the-year alewives hatch mainly in June and July and are found off the mouth of the river at mid-level depths until late summer or fall (Wells 1968).

Palisades Power Plant (42°19', 86°19'). Spawning was observed near the plant in 3 ft of water (Wapora 1979c). Peak numbers of adults generally have been impinged or collected in April and May as they moved inshore to spawn (Consumers Power 1975, 1972b; Patriarche 1971a; Wapora 1979c,d). Ripe adults have been found in the area in June (Consumers Power 1972b; Patriarche 1972; Wapora 1979c). Eggs have been found at the power plant from June to August; the maximum numbers are collected in June (Consumers Power 1972b; Patriarche 1972; Wapora 1979c). In 1978, alewife eggs were 92% of the estimated total eggs entrained; alewife eggs were collected from early June to early August, and density peaked in early June (Wapora 1979c). Alewife fry were collected in large numbers near the power plant in water as shallow as 4 ft. Young-of-the-year were present in the area in July and August, and thousands were seined in the area and impinged at the plant as late as October (Consumers Power 1973a, 1974, 1975; Patriarche 1971a,b, 1973b, 1974; Wapora 1979).

St. Joseph River (42°07', 86°29'). Spawning migrations were observed into the St. Joseph and Paw Paw (42°07', 86°28') rivers, and ripe males and females were collected there (Brown 1970b, 1972; Brown, pers. comm. 1979).

Bridgman (41°56', 86°35'). Spawning was observed in the beach zone from the Cook Power Plant (41°59', 86°34') south to the Warren Dunes State Park (41°54', 86°37'), from the shoreline out to about the 30 ft depth contour (Jude 1976a; Jude, Dorr, and Tesar, pers. comm. 1979). The substrate in the area is sand and scattered rocks out to about the 84 ft depth contour; from Benton Harbor (42°06', 86°27') southward it is silt mixed with sand beyond the 72 ft depth contour (Wells 1972). Adults migrate inshore from March to May. Most adults are usually found in June; ripe, running, and spent adults are taken in June and July (Indiana and Mich. Power 1975; Jude et al. 1975, 1979b). Spawning generally occurs during June and July; however, in some years spawning is observed as early as late May and as late as early August. Peak spawning usually occurs in late June and early July. Spawning was observed, and large numbers of ripe-running adults, eggs, and 1-day-old larvae were collected here from June through August (Brown, pers. comm. 1979; Indiana and Mich. Power 1975; Jude et al. 1975, 1979b; Jude, Dorr, and Tesar, pers. comm. 1979). The Bridgman area is also an important nursery ground. Alewife larvae are collected along the shore throughout the area and are more abundant than larvae of other species. Alewife larvae are found in the epilimnion out to the 70 ft depth contour but are more concentrated in the beach zone. They have been collected in large numbers at about the 20- and 30 ft depth contours during the summer months. Alewife larvae first appear in collections in late May and early June and are generally encountered in the beach zone area from June to August. Peak abundance of larvae varies from year to year, but it often occurs in late June and early July (Indiana and Mich. Power 1975; Jude 1976a, 1977; Jude et al. 1975, 1979b; Jude, Dorr and Tesar, pers. comm. 1979). Very large numbers of YOY are found in the beach zone from July to October (Indiana and Mich. Power 1975; Jude et al. 1973, 1975, 1979b). Young-of-the-year have been observed in large schools at depths of 30 ft or less near the intake and discharge structures during July to September (Dorr 1976, 1977). Young-of-the-year appear to move away from the beach zone to deeper waters in November (Indiana and Mich. Power 1975).

GIZZARD SHAD

The gizzard shad presumably entered Lake Michigan via the Chicago River Canal (41°53', 87°37'), Illinois. The first recorded capture of gizzard shad in Lake Michigan occurred near Muskegon, Michigan, and Gary, Indiana, in 1953 (Miller 1957). Populations of gizzard shad are generally concentrated near and in rivers (Belonger, pers. comm. 1979).

Wisconsin

All of Green Bay (45°05', 87°25') is potentially a reproductive site for gizzard shad (Kernen, pers. comm. 1979).

WM-1

Fox River (44°32', 88°00'). In 1975, eggs tentatively identified as those of gizzard shad were collected in June at the Pulliam Power Plant (44°32', 88°00'), and a few young-of-the-year (YOY) were subsequently collected in July from both Green Bay and the Fox River. Young-of-the-year may be attracted to the heated discharge from the plant in the winter; many were impinged at the plant in December (NALCO, undated a). Gizzard shad were collected in the lower Fox River, suggesting that spawning occurs in the river (Becker 1976).

Indiana

Bailly Generating Station (41°39', 87°07'). In 1976, spawning occurred here. Eggs were entrained at the station during the last week in June (Tex. Instrum. 1976b, as cited in Tex. Instrum. 1977b, 1976c); eggs were also collected in August east of the station (Tex. Instrum. 1977b). Egg densities were highest in the discharge plume. In 1974, gravid adults were collected in the area (Tex. Instrum. 1974b).

Michigan

MM-6

Pere Marquette (43°56', 86°26') and Pentwater (43°46', 86°24') Rivers. Spawning is suspected to occur in the river mouths because YOY about 4 in. long were collected, although not commonly, in late fall at the Ludington Pumped Storage Plant (43°54', 86°27') (Brazo, pers. comm. 1979).

MM-7

Grand River (43°03', 86°15'). Significant reproduction probably occurs in the river. Young-of-the-year have been seen in the river (Jude, pers. comm. 1979), and in 1977, thousands of young about 1 in. long were observed along the docks in Grand Haven (43°04', 86°13') during the summer (Jude et al. 1978).

Port Sheldon (42°54', 86°13'). No ripe adults were collected here, but the discharge canal of the Campbell Power Plant (42°55', 86°12') is considered to be prime spawning habitat (Jude et al. 1978). Larvae were found offshore in August (Wapora 1979a), and YOY were collected at beach stations north and south of the plant in July (Jude, pers. comm. 1979).

MM-8

Kalamazoo River (42°40, 86°13'). Gizzard shad were collected in the lower river, suggesting that spawning may occur in the river (Becker 1976).

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LONGJAW CISCO

This species is believed to be extinct in the Great Lakes (Todd, pers. comm. 1981). The last recorded capture of the longjaw cisco in Lake Michigan occurred in Grand Traverse Bay, Michigan, in 1967 (Todd 1978). The longjaw cisco is now considered to be taxonomically synonymous with the shortjaw cisco (Todd and Smith, unpubl. data). The longjaw cisco generally spawned in October and November in Lake Michigan (Hile, pers. comm. 1979; Jobes 1946; Koelz 1929).

Wisconsin

WM-5

Sheboygan (43°45', 87°42'). In the early 1930s, spent females were taken here in 228-300 ft of water in mid-October (Jobes 1946).

Port Washington (43°23', 87°52'). In the early 1930s, one ripe female was collected here in about 450 ft of water in mid-September (Jobes 1946).

Milwaukee (43°02', 87°54'). In the early 1930s, one ripe male was collected here in 192-216 ft of water in late October (Jobes 1946).

WM-6

Racine (42°44', 87°47'). In the early 1930s, spent females were taken in 252 ft of water in early November (Jobes 1946).

Illinois

Waukegan (44°22', 87°50'). In the early 1930s, spent females were taken here in 204-270 ft of water in early November (Jobes 1946).

Michigan

MM-2

Manistique (45°57', 86°15'). In the early 1930s, one ripe female was taken here in 384-408 ft of water in early July (Jobes 1946).

MM-3

Beaver Island (45°40', 85°33'). In 1929, spawning occurred off the east shore of the island over substrate of mud, clay, and rock (Koelz 1929).

Little Traverse Bay (45°24', 85°00'). In 1929, spawning occurred over mud, clay, and rock substrate (Koelz 1929).

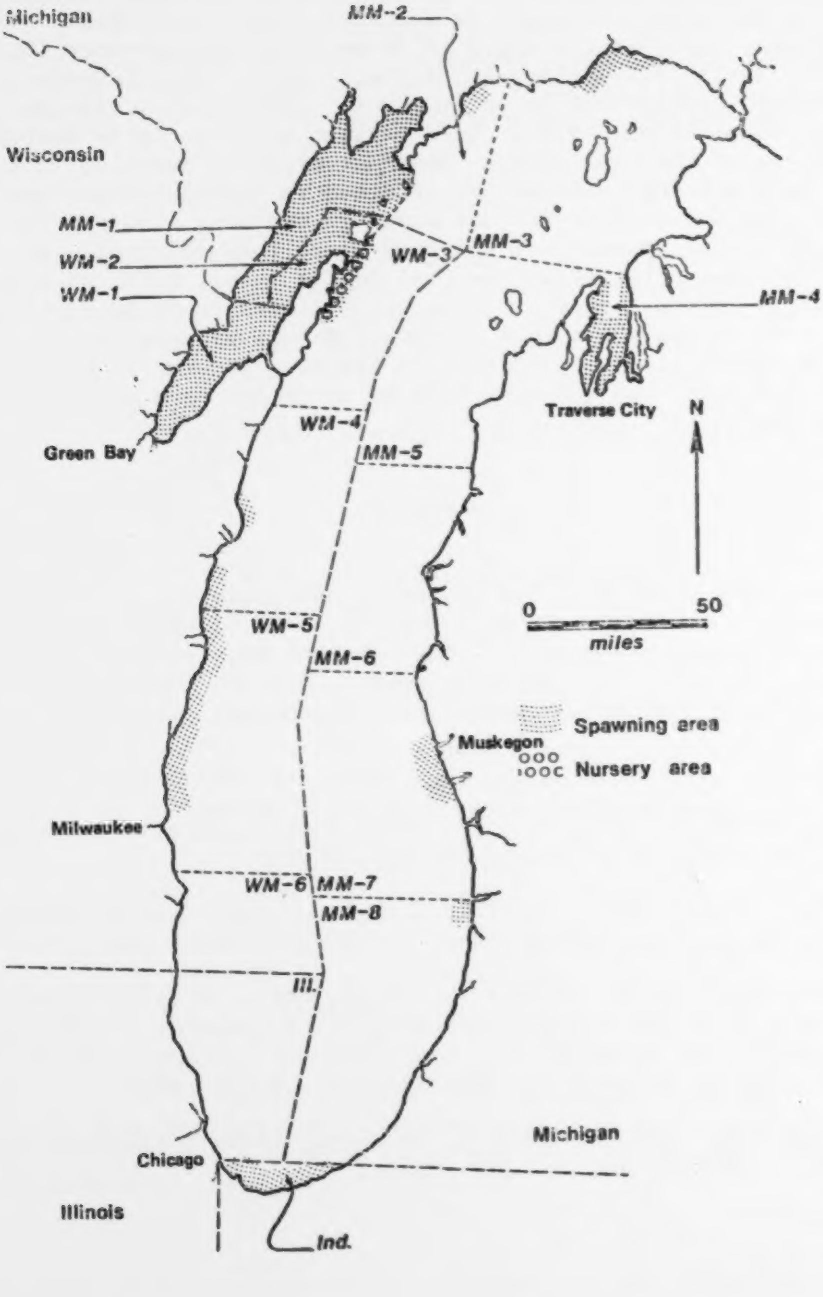
MM-4

Grand Traverse Bay (45°05', 85°30'). In 1929, spawning occurred over mud, clay, and rock substrate (Koelz 1929).

MM-6

Ludington (43°57', 86°28'). In the early 1930s, one ripe female was collected here in about 156 ft of water in early August (Jobes 1946).

LAKE HERRING



Michigan
MM-2
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Lake herring are much less abundant now than they formerly were in Lake Michigan. The major decline in lake herring abundance, which began in 1957, has been attributed to the resurgence of rainbow smelt to considerable abundance by the 1950s and the explosive increase in alewives which began in the mid-1950s (Wells and McLain 1972, 1973). Presently, lake herring stocks in general are continuing to decline; local populations are either abundant or depleted (Todd, pers. comm. 1981). In Lake Michigan, lake herring spawn in November to mid-December (Hile, pers. comm. 1979; Koelz 1929; Milner 1874a; Smith 1954, 1956). Commercial fisheries were carried out in Green Bay for lake herring when they moved inshore to spawn (Koelz 1929). Lake herring moved in large numbers to inshore areas of the bay in early November prior to spawning (Milner 1874a). Lake herring in Green Bay remained in schools during the spawning period; all of the schools did not spawn at the same time nor did they necessarily finish spawning at the same place they started. Lake herring appeared to spawn pelagically over all depths in all parts of Green Bay but preferred inshore areas and were concentrated in 10-60 ft of water. Spawning also may have occurred in deeper water, because both ripe and spent fish were collected at depths to 140 ft. Lake herring spawned over boulders, sand, and mud and exhibited no preference for a particular substrate (Smith 1954, 1956).

Wisconsin

In southern Green Bay, the run began approximately October 25, reached Marinette (45°05', 87°36') approximately November 11-12, and ended approximately December 10. Lake herring were also fished along the east shore during the fall spawning season, but the run was not as heavy as the one on the western shore (Coberly and Horrall 1980b).

WM-1

Green Island (45°03', 87°30'). Lake herring were fished here during the spawning season (Coberly and Horrall 1980b).

Peshtigo Reef (44°58', 87°36'). This was once a heavily used spawning area; few fish now use the area (Copes, pers. comm. 1979).

Oconto Shoal (44°51', 87°47'). In the 1920s, this was a heavily used spawning area. In 1920, a few fish were found spawning off Oconto (44°53', 87°52') on November 17. Peak spawning usually occurred over sand bottom in 10-25 ft of water in late November (Koelz 1929).

Larsens Reef (44°53', 87°29'). Fishermen caught spawning lake herring here (Coberly and Horrall 1980b).

WM-2

Door Peninsula (45°05', 87°10'). Fishermen caught spawning lake herring at Egg Harbor (45°03', 87°17')--Fish Creek (45°08', 87°15'), Eagle

Bluff (45°10', 87°14'), Ellison Bay (45°15', 87°05')--Table Bluff (45°18', 87°01'), and the nearshore area east of Table Bluff--Waverly Shoal (45°17', 86°57') (Coberly and Horrall 1980b). In 1951, despite intensive sampling in Green Bay, only 2 young-of-the-year (YOY) were found; these were found off Gills Rock (45°17', 87°02') in 102 ft of water in December (Smith 1954, 1956).

Washington Island (45°23', 86°54'). Spawning areas include Detroit Harbor (45°21', 86°55'), Hog Island (45°21', 86°51'), and from Washington Harbor (45°25', 86°55') to Rock Island (45°25', 86°49') (Coberly and Horrall 1980b).

WM-3

Rowley Bay (45°13', 87°01')--Baileys Harbor (45°03', 87°07'). The entire Lake Michigan shore of the peninsula from Baileys Harbor north may be a spawning and nursery area for lake herring. Larvae, presumed to be lake herring, were found in Baileys Harbor, Moonlight Bay (45°05', 87°05'), and North Bay (45°09', 87°04'). In 1979, larvae about 0.2 in. long were found in Rowley Bay in April (Leary, Booke, Copes, and Ebener, pers. comm. 1979). Fishermen caught spawning lake herring in North Bay and Rowley Bay (Coberly and Horrall 1980b).

WM-4

Rawley Point (44°13', 87°30'). Fishermen caught spawning lake herring here (Coberly and Horrall 1980b).

WM-5

Port Washington (43°23', 87°52'). In this area, spawning occurred over sand along shore in 10-25 ft of water; peak spawning occurred about November 20, and the fish remained on the spawning grounds until December (Koelz 1929). In 1975, one larva was entrained at the Port Washington Power Plant (43°23', 87°52') on April 15 (Wis. Elec. Power 1976e). The shoreline extending north from Port Washington to 5 mi S of Manitowoc (44°01', 87°38') and south to Milwaukee Bay (43°02', 87°52') is a spawning ground (Coberly and Horrall 1980b).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In 1972, one ripe-running female lake herring was collected in this area in late November. The substrate in the area is fine sand with a few rocks (Cochran, undated; LaJeone, pers. comm. 1979).

Indiana

Lake herring spawned anywhere along shore in 25-40 ft of water.

Miller Beach (location unknown). In the late 1930s, ripe-running adults were collected here in late November (Westerman, pers. comm. 1979).

Michigan

MM-1

Menominee (45°07', 87°37')--Escanaba (45°45', 87°04). During the 1800s, one of the principal fishing grounds extended from Menominee north, approximately to Escanaba, where the most abundant species found was the "shoal" herring (MSBFC 1897, 1899). A spawning run occurred at Escanaba in late fall and early winter (Smith and Snell 1891). Until the 1940s, lake herring spawned off the mouth of No-See-Um Creek (45°39', 87°11') over sand and rock at depths of 12-40 ft; during the 1920s to 1950s, spawning occurred at Arthur Bay (45°19', 87°26') over sand in 18-24 ft of water (Organ et al. 1978). Fishermen have recently reported that ripe lake herring were caught almost everywhere in the northern half of Green Bay during the spawning season, and that the west shore was the major spawning ground. Spawning occurred over a varied substrate of mud, clay, sand, or fine gravel in water as shallow as 5-10 ft (Coberly and Horrall 1980b).

Big Bay de Noc (45°45', 86°45'). During the 1940s, lake herring spawned in an area (45°41', 86°46'--45°35', 86°50') extending from about 4 mi SE of Chippewa Point (45°43', 86°50') toward Wilsey Bay Point (45°42', 86°55') over rock, sand, and mud at depths of 45-60 ft. Spawning also occurred in an area extending from Chippewa Point southward toward Eleven Foot Shoal (45°38', 86°59') over sand, gravel, and mud in water 40-60 ft deep (Organ et al. 1978).

MM-2

Manistique (45°57', 86°15'). Until the 1950s, lake herring spawned in an area (45°56', 86°17') SW of Manistique; spawning occurred near shore over sand and gravel in water about 12-18 ft deep (Organ et al. 1978).

MM-3

Scott Point (45°58', 85°42')-- Davenport Creek (46°04', 85°16'). From the 1950s to 1972, lake herring spawned in an area from Scott Point to 46°02', 85°16', near the mouth of Davenport Creek; spawning occurred over rock and gravel at depths of 5-30 ft in November (Organ et al. 1978).

MM-4

Grand Traverse Bay (45°05', 85°30'). Spawning apparently occurred along the shores of the bay over sand in 10-25 ft of water. Spawning peaked around November 20, and adults remained on the spawning grounds until December (Koelz 1929).

MM-7

Muskegon (43°13', 86°17'). "Greenback herring" spawned along about 5-6 mi of the shoreline from Mona Lake (43°10', 86°18') to White Lake (43°23', 86°26'). During 1932-70, spawning occurred over sandy bottom in less than 10 ft of water (Organ et al. 1978).

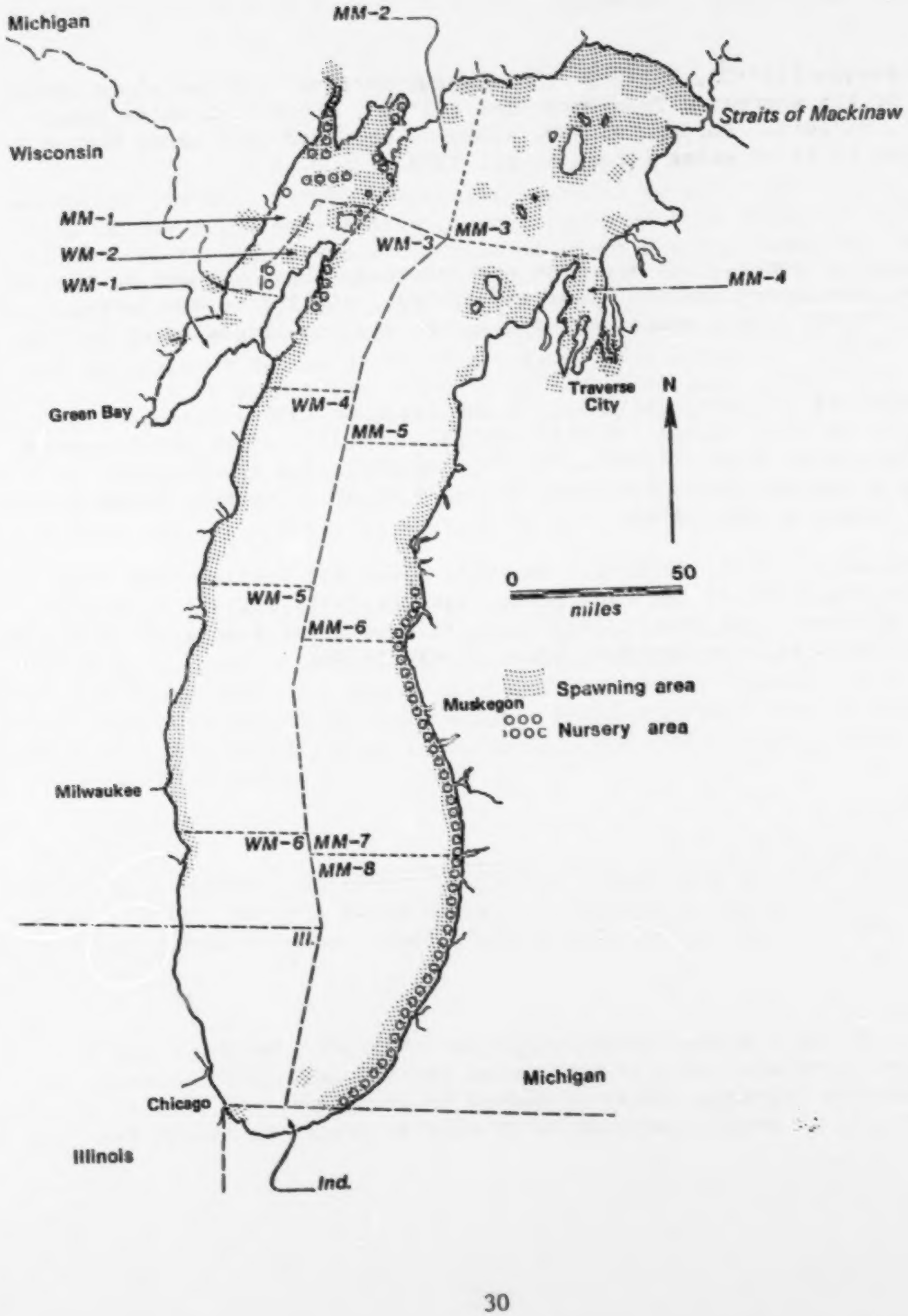
MM-8

Spawning could occur anywhere near shore in the southeast portion of the lake from approximately Saugatuck (42°40', 86°12') to New Buffalo (41°48', 86°45'), but would be light due to the low abundance of adults (Wells 1972).

Saugatuck (42°40', 86°12'). In the 1940s to 1950s, greenback herring spawned in an area (42°42', 86°17'--42°45', 86°17') 3-4 mi off the mouth of the Kalamazoo River (42°40', 86°13') and north for about 3 mi. Spawning occurred over mud bottom in 90-108 ft of water from November to January (Organ et al. 1978).

Bridgman (41°56', 86°35'). In 1972, seven YOY smaller than 1 in. long were captured off the Cook Power Plant (41°59', 86°34') in August through October (Jude et al. 1973). In 1974, a spent female was captured near the plant in late December (Jude et al. 1979b).

LAKE WHITEFISH


Michigan
MM-2
Wisconsin
Straits of Mackinaw
MM-1
WM-2
WM-1
MM-3
WM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Records of the fishery conducted for lake whitefish in Lake Michigan during the spawning season indicate that spawning occurs in shallow shoreline waters of the entire lake in times of high abundance, and that spawning may be restricted to a few local areas when abundance is low. Adults begin concentrating in the shallow areas in October (Smith 1909), and generally spawn during a 2-4 week period in late November and December when the water temperature falls to about 40-46°F (Daly et al. 1975; GLFL 1970; Koelz 1929; Price and Kelly 1976; Smith 1909). Spawning occurs over gravel, stone, or honeycombed rock, swept clean by currents, at depths of 6-60 ft (Davidson 1937; Grosse Ile Lab. 1972; Koelz 1929; Price and Kelly 1976; Walburg 1973). Spawning also occurred over "round-heads," (areas of boulder rock on sand bottom) (Smith 1909). After spawning, adults return to the deeper offshore waters (Davidson 1937). Wisconsin fishermen reported that lake whitefish enter sandy bays to spawn in as little as 10 ft of water, in contrast to lake trout which spawn on rock shoals farther offshore (Coberly and Horrall 1980b).

Historically, lake whitefish spawned in tributaries and near river mouths (Wells and McLain 1972). In the 1800s, the principal spawning grounds along the west shore of Green Bay were in the tributaries emptying into the bay (Geare 1884; Smiley 1882). Lake whitefish were taken in great numbers in these rivers during the spawning season (Milner 1874a; Smiley 1882). Prior to 1897, spawn was collected from ripe fish taken on the west and north shores of the bay (Nevin 1899). The tributary runs ceased when sawmill wastes polluted the rivers (Milner 1874a; Smiley 1882).

In the 1870s, lake whitefish spawned in an area beginning south of Racine (42°44', 87°47'), Wisconsin, and continuing north along the entire shore. No known spawning grounds were recorded for Chicago (41°53', 87°37') and Illinois waters (Milner 1874a; Smith and Snell 1891). No spawning grounds were reported in the area from St. Joseph (42°06', 86°29'), Michigan, south to Michigan City (41°44', 86°54'), Indiana. Spawning grounds south of Frankfort (44°38', 86°14'), Michigan, were few and unimportant (MSBFC 1897).

Lake whitefish larvae are usually most abundant near the surface. They frequent shallow inshore areas and bays not more than 10 ft deep. When the larvae are about 0.8 in. long, they begin to seek the bottom in deeper waters (Hoagman 1973; Hogman 1971).

Wisconsin

WM-1

Menominee River (45°06', 87°35'). Historically, spawning runs entered the river (Ebener and Copes, pers. comm. 1979; Imhof, pers. comm. 1979). The river, which forms the boundary between Wisconsin and Michigan, supported an important fishery; thousands of lake whitefish were taken here as they returned to the lake after spawning (Geare 1884; True 1887). However, no whitefish were taken in the river after 1870 (Smiley

1882), and by the late 1800s spawning grounds in Green Bay at a considerable distance from the river mouth had been completely ruined by wastes from sawmills located on the river (Smiley 1882; True 1887).

Green Island (45°03', 87°30'). A commercial fisherman reported that spawning occurred here (Coberly and Horrall 1980b).

Peshtigo Reef (44°58', 87°36'). Lake whitefish spawned here historically, and in the 1970s, ripe fish were collected on the reef (Ebener and Copes, pers. comm. 1979). Tagging studies indicate that lake whitefish also move from the reef to North (45°09', 87°04') and Moonlight (45°05', 87°05') bays to spawn and then return to the reef (Gunderson 1978).

Oconto River (44°54', 87°50'). In 1845, lake whitefish ran 20 mi upstream to the falls to spawn; by the late 1800s the river bottom and shoals in Green Bay at a considerable distance from the river mouth were covered by wastes from sawmills located on the river (Smiley 1882).

WM-2

Chambers Island (45°11', 87°21'). Spawning does not appear to occur here, but lake whitefish larvae are found regularly at the island, especially off the east shore in water less than 10 ft deep (Hoagman 1973; Hogman 1971). Lake currents may transport these larvae to the site from a spawning ground in Big Bay de Noc (45°45', 86°45') (Frederick, pers. comm. 1979; Hoagman 1973; Hogman 1971). In 1970, hatching in areas contributing larvae to the nursery grounds at the island peaked in late April; yolk-sac larvae captured at the island by May 2 were more than 7 days old. The nursery area on the east side of the island has a rocky bottom with patches of sand; the water depth is about 1-6 ft; there is no vegetation in this area, and a large rock shelf reduces water currents. Larvae inhabit these nearshore waters until mid-May, after which they move to deeper water and become difficult to capture (Hoagman 1973; Hogman 1971). In the late 1970s, tagged adult whitefish moved from Chambers Island to spawn in North (45°09', 87°04') and Moonlight (45°05', 87°05') bays and then returned to the island (Gunderson 1978).

Horseshoe Island (45°11', 87°13') (Coberly and Horrall 1980b).

Horseshoe Reefs (45°13', 87°12') (Imhof, pers. comm. 1979). Recently spent fish with spawning tubercles were captured here in February, indicating that spawning may have occurred in late January and February (Ebener and Copes, pers. comm. 1979).

Sister Islands (45°13', 87°09') and Sister Shoals (45°12', 87°10') (Imhof, pers. comm. 1979).

Washington Island (45°23', 86°54'). Prior to 1868, some of the most important spawning grounds for lake whitefish were located north and west of Washington Island; these grounds extended to St. Martin Island (45°30', 86°46') (Smiley 1882). Spawn was collected from ripe fish taken near

Detroit Harbor (45°21', 86°55') (Nevin 1901b). Lake whitefish spawn off the east shore of Washington Island from 45°24', 86°49'--45°20', 86°49' (Coberly and Horrall 1980b; Imhof, pers. comm. 1979).

Fish Island (45°24', 85°46') and Fisherman Shoal (45°22', 85°47'). Spawning occurs here (Coberly and Horrall 1980b; Imhof, pers. comm. 1979).

Waverly Shoal (45°17', 86°57'), Nine Foot Shoal (45°17', 86°57'), and Europe Bay (45°16', 86°59'). Spawning occurs here (Coberly and Horrall 1980b).

WM-3

The major lake whitefish spawning grounds in Wisconsin waters of Lake Michigan are located along the eastern shore of the Door Peninsula from Europe Bay (45°16', 86°59') south to Cave Point (44°56', 87°10') in water as shallow as 10 ft (Coberly and Horrall 1980b).

Europe Bay (45°16', 86°59')--Four Foot Shoal (45°10', 87°00') (Imhof, pers. comm. 1979). Spider Island (45°13', 86°59') is an especially important spawning area (Coberly and Horrall 1980b).

Rowley Bay (45°13', 87°01'). This is an important spawning area (Coberly and Horrall 1980b). Ripe lake whitefish are present in Rowley Bay during the last week in October (Ebener and Copes, pers. comm. 1979). Larvae have been collected at the head of the bay over rock bottom with patches of sand (Frederick, pers. comm. 1979).

North Bay (45°09', 87°04')--Baileys Harbor (45°03', 87°07'). This entire area, including Moonlight Bay (45°05', 87°05'), is a major spawning ground for lake whitefish (Ebener and Copes, pers. comm. 1979; Imhof, pers. comm. 1979). Especially important sites are Cana Island (45°05', 87°03') (Coberly and Horrall 1980b) and North Bay, where spawning occurs at the mouth of the bay and along shore toward Cana Island over honeycombed rock (Binkowski, pers. comm. 1979; FWS 1979d; Hoagman 1973; Hogman 1971; Imhof 1977, pers. comm. 1979). It was estimated that 75% of the lake whitefish caught in the Wisconsin waters of Lake Michigan in 1976 were produced from spawnings in North and Moonlight bays (Humphreys 1978). Tagging studies indicate that homing occurs to specific bays in the area (Humphreys 1978; Imhof 1978); fish move into the bays from Lake Michigan proper and from Green Bay, especially Peshtigo Reef (44°58', 87°36') and Chambers Island (45°11', 87°21'), to spawn (Ebener and Copes, pers. comm. 1979; Frederick, pers. comm. 1979; Gunderson 1978; Hoagman 1973; Hogman 1971; Humphreys 1978; Moore, pers. comm. 1979). Large concentrations of ripe fish are found along the entire shore from North Bay to Baileys Harbor in water 40 ft deep or less from mid-October through November (Frederick, pers. comm. 1979); the greatest numbers are found near North Bay in October (Hoagman 1973; Hogman 1971). Substrate in the area to water depths of 30 ft is shelf rock containing many crevices; at depths of 30-60 ft the substrate is honeycombed rock (Frederick, pers. comm. 1979). In 1970, lake whitefish arrived at North Bay on about November 1; peak spawning activity occurred on about November 10 (Hoagman 1973; Hogman

1971). Eggs hatch in early to mid-April, as soon as the ice cover breaks up (Frederick, pers. comm. 1979). North Bay, Moonlight Bay, Baileys Harbor, and the surrounding nearshore waters are nursery areas (Frederick, pers. comm. 1979; Moore, pers. comm. 1979). Many newly hatched larvae are present in North Bay in April and May; most are found at depths of less than 3 ft (Hoagman 1973; Hogman 1971). Young-of-the-year (YOY) remain in the bays until late May; they are collected along shore at depths of less than 80 ft until September or October (Frederick, pers. comm. 1979).

Whitefish Point (44°52', 87°12'). Commercial fishermen have recently identified this area as a spawning ground (Coberly and Horrall 1980b).

WM-4

Kewaunee Power Plant (44°21', 87°32'). An occasional ripe lake whitefish is collected in waters off the plant. The substrate in the area is generally hard clay with cobble-size rock (LaJeone, pers. comm. 1979).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In the 1970s, no evidence of spawning was found here (Commonw. Edison 1976; USAEC 1972c); however, young lake whitefish (possibly YOY and yearlings) were collected in the area over a substrate of fine sand and rock (LaJeone, pers. comm. 1979).

Indiana

Whiting (41°41', 87°30'). Historically, large numbers of lake whitefish spawned a short distance offshore at "South Chicago" (Nelson 1878), which was approximately at the present location of Whiting.

Bailly Generating Station (41°39', 87°07'). In 1974, one ripe lake whitefish was collected about 3 mi N of the station at the 15 ft depth contour during the spawning season (Tex. Instrum. 1975b).

Michigan City (41°43', 86°54'). During 1945-68, lake whitefish spawned in an area (41°44', 86°55') about 3 mi offshore in 55-60 ft of water (Organ et al. 1978).

Michigan

MM-1

Whaleback Shoal (45°21', 87°11'). Spawning occurs here (Imhof, pers.

Arthur Bay (45°19', 87°26'). During the 1920s to 1940s, spawning occurred here over sand in water about 20 ft deep (Organ et al. 1978).

Cedar River (45°24', 87°21'). Historically, lake whitefish entered this river to spawn (Imhof, pers. comm. 1979).

Bark River (45°34', 87°14'). In 1978, larvae were collected off the river mouth from late April to late May (Wis. Elec. Power, unpubl. data).

Minneapolis Shoal (45°35', 87°00'), Drisco Shoal (45°34', 86°57'), and North Drisco Shoal (45°33', 86°57'). Since 1915, spawning has occurred on these shoals over rock (Imhof, pers. comm. 1979; Organ et al. 1978). The shoals are also nursery areas for YOY and yearling lake whitefish (Ebener and Copes, pers. comm. 1979).

Little Bay de Noc (45°45', 87°00'). The portion of the bay north of Portage Point (45°42', 87°04') is a spawning and nursery area for lake whitefish. Running-ripe fish were collected in this area (Ebner, Copes, and Leary, pers. comm. 1979).

> Ford River (45°40', 87°08'). In 1978, a few eggs were found just off the mouth of the Ford River at the 5 and 10 ft depth contours in mid-April; larvae were found from late April to late May (Wis. Elec. Power, unpubl. data).
>
> Stonington (45°45', 86'59'). Since the 1920s, spawning has occurred off Stonington over rock in about 6-12 ft of water (Organ et al. 1978).
>
> Whitefish River (45°55', 86°57'). Before paper mills were constructed in the area, spawning runs of lake whitefish entered the river (Ebener, Copes, and Leary, pers. comm. 1979).

Big Bay de Noc (45°45', 86°45'). Spawning occurs in the bay (Ebener and Copes, pers. comm. 1979; FWS 1979d; Hile, pers. comm. 1979; Hoagman 1973; Hogman 1971), mostly in the inner bay north of the tip of Big Bay de Noc Shoal (45°45', 86°42') (Ebener and Copes, pers. comm. 1979). In the early 1890s, lake whitefish were more abundant in the bay in the fall, during the spawning season, than in the spring (Smith and Snell 1891). A tagging study conducted in 1954 and 1955 indicates that lake whitefish in the bay are not migratory (Gunderson 1978; Roelofs 1958); however, WDNR records show that some fish tagged in central Green Bay migrated to Big Bay de Noc to spawn (Hoagman 1973; Hogman 1971). In the 1920s, lake whitefish spawned at the north end of the bay near Isabella (45°53', 86°36') and at "humps" (location unknown) in the bay in November (Van Oosten 1927a). According to commercial fishermen, the primary spawning grounds occur along the eastern shore of the bay, just north of Garden (45°46', 86°33'); this area receives strong currents from Lake Michigan proper (Hoagman 1973; Hogman 1971). Since 1915, lake whitefish have spawned along the entire shoreline from Garden Bluff (45°47', 86°37')--Peninsula Point (45°40', 86°58'), at the 12 ft depth contour over rock, gravel, and sand (Organ et al. 1978). Lake whitefish larvae that are spawned in Big Bay de Noc probably disperse to the Chambers Island (45°11', 87°21') area (Hoagman 1973; Hogman 1971).

Round Island (45°45', 86°46'). Since 1915, lake whitefish have spawned on the shoals around the island over rock and gravel (Organ et al. 1978). This is probably the same area, 5 mi WNW of Fayette (45°43', 86°40'), where spawning occurred in 1937 at depths as shallow as 4 ft (Van Oosten 1938b).

Big Bay de Noc Shoal (45°45', 86°42'). Since 1920, lake whitefish have spawned here over rock, gravel, and sand. Spawning also occurs (no dates given) on the adjacent shoal (45°47', 86°40) at depths of about 18-20 ft, over sand and rock (Organ et al. 1978).

Valentine Bay (45°50', 86°33'). In 1970, many larvae were collected here in early May (Hoagman 1973; Hogman 1971).

Kates Bay (45°49', 86°34'). Spawning occurs here, and in 1970 many lake whitefish larvae were collected in the bay in early May (Hoagman 1973; Hogman 1971).

Burnt Bluff (45°41', 86°42'). Since 1915, spawning has occurred here over sand and gravel (Organ et al. 1978).

St. Martin Island (45°30', 86°46') and St. Martin Island Shoals (45°27', 86°46'). Prior to 1868, some of the best spawning grounds for lake whitefish were south and west of St. Martin Island; these grounds extended to Washington Island (43°23', 86°54') (Smiley 1882). Since 1915, spawning has occurred on the shoals and along the south shore of the island (Organ et al. 1978).

Poverty Island Shoal (45°33', 86°42'), Gravelly Island Shoals (45°32', 86°44'), Gravelly Island (45°31', 86°44'), Gull Island (45°31', 86°43'), and Little Gull Island (45°30', 86°43'). Since 1915, lake whitefish have spawned here over rock and gravel (Organ et al. 1978).

Poverty Island (45°32', 86°40') and south shore of Summer Island (45°34', 86°38'). Spawning occurs (no dates given) on the shoals here (Organ et al. 1978).

Rocky Island (45°37', 86°43') and Little Summer Island Shoal (45°35', 86°43'). Since 1915, spawning has occurred here over rock (Organ et al. 1978).

Sac Bay (45°39', 86°42'). In 1915-78, lake whitefish spawned here over sand and gravel (Organ et al. 1978).

Point Detour (45°36', 86°37') and Fairport (45°37', 86°40'). In 1970, small numbers of larvae were caught here (Hoagman 1973; Hogman 1971).

MM-2

In the early 1890s, spawning lake whitefish were caught along the shores of Schoolcraft County (Smith and Snell 1891).

Kregg Bay (45°42', 86°34'). From 1915 to 1978, lake whitefish spawned on the rock shoal (45°41', 86°31'), about 2 mi E of the bay (Organ et al. 1978).

Portage Bay (45°45', 86°31')--Point aux Barques (45°48', 86°21'). According to fishermen, lake whitefish probably spawn on the rocky shoals in this area (Ebener and Copes, pers. comm. 1979); spawning sites in this area include:

> Portage Bay. Since 1915, spawning has occurred on the rock and gravel shoal areas of this bay; the bay is probably a nursery area for lake whitefish (Ebener and Copes, pers. comm. 1979).
>
> A rock area (45°44', 86°28'), between Portage Bay and Parent Bay. From 1915 to 1978, spawning occurred here at depths of 6-24 ft (Organ et al. 1978).
>
> Parent Bay (45°47', 86°25'). From the 1920s to 1978, spawning occurred here over rock and gravel (Organ et al. 1978).
>
> Point aux Barques. From 1940 to 1978, spawning occurred over rock and gravel in water 12-30 ft deep (Organ et al. 1978).

Wiggins Point Shoal (45°51', 86°18'). From 1915 to 1978, spawning occurred here over rock and gravel at depths of less than 30 ft (Organ et al. 1978).

Dutch Johns Point (45°57', 86°08'). From the 1920s to 1978, lake whitefish spawned here over gravel from the shoreline to depths of 25 ft (Organ et al. 1978).

MM-3

The north shore of Lake Michigan, especially the reefs around the islands, was historically one of the most productive lake whitefish spawning grounds. By the 1890s, sawdust pollution entering the lake from the Manistique River (45°57', 86°15') had fouled spawning grounds and reduced the catch of lake whitefish in this area (Koelz 1929; MSBFC 1887, 1893, 1895, 1897).

Seul Choix Point (45°55', 85°55'). In 1975 and 1976, lake whitefish were captured here during the spawning season (Imhof 1977); fishermen presently catch ripe fish here (Leary and Copes, pers. comm. 1979).

Boulder Reef (45°36', 85°58'). Historically, this reef was one of the largest spawning areas in the lake (Koelz 1929); spawning occurred here in November and December (Van Oosten 1927a). Until 1948, spawning occurred here over rock in less than 30 ft of water (Organ et al. 1978).

Gull Island (45°42', 85°50'). Spawning occurred here (MSBFC 1890).

Scott Point (45°58', 85°42')--Pointe aux Chenes (45°56', 84°54'). Spawning occurs along shore in this area (Organ et al. 1978). In the early 1890s, many spawning lake whitefish were caught along the shores of Mackinac County in late November (Smith and Snell 1891).

> Scott Point (45°58', 85°42')--Rock River (46°05', 85°32'). From the 1940s to 1978, spawning occurred here along shore over sand, rock, and gravel at depths of 6-24 ft (Organ et al. 1978).
>
> Rock River (46°05', 85°32')--Biddle Point (46°05', 85°23'). From 1967 to 1969, spawning occurred along shore here over rock, sand, and gravel (Organ et al. 1978). Naubinway (46°00', 85°27') was a base for spawn collection (Clark 1886), and spawning occurred during November (Van Oosten 1927a). Lake whitefish spawned at Naubinway Island (46°04', 85°27') over sand and rock at depths of 30 ft or less (Organ et al. 1978), and in Mille Coquins Bay (46°05', 85°29') from October 25 to November 25 (Van Oosten 1927a).
>
> Biddle Point (46°05', 85°23')--Davenport Creek (46°04', 85°16'). From the 1940s to 1978, spawning occurred here over rock and gravel (Organ et al. 1978). Spawning occurred on an unnamed reef south of Little Hog Island (46°04', 85°18') from October 20 to November 10 and on a reef (precise location unknown) 6 mi E of Naubinway (46°06', 85°27'), which would be just west of Little Hog Island, from November 5 to 25 (Van Oosten 1927a).
>
> Davenport Creek (46°04', 85°16')--Epoufette (46°03', 85°10'). Epoufette was a base for spawn collection (Clark 1886). From 1967 to 1969, spawning occurred in this area over rock, sand, and gravel. From 1961 to 1978, spawning occurred at Pelkie Reef (46°02', 85°15') over rock at depths of 11-30 ft (Organ et al. 1978).
>
> Brevoort River (45°57', 84°56')--Pointe aux Chenes Bay (45°55', 84°53'). From 1961 to 1978, spawning has occurred here over rock and gravel substrate, from the shore out to a depth of about 30 ft (Organ et al. 1978).

South Tarp Island (location unknown). Spawning occurred here on December 10-20 (Van Oosten 1927a).

Beaver Island (45°40', 85°33'). Historically, spawning occurred here during a 3 week period in November to December (Strang 1855). In the 1920s, spawning occurred during November 12-25 at the north end of the island and during November 15-30 at Kelty Point (45°37', 85°29') (Van Oosten 1927a). In 1970, ripe fish were captured at the north end of the island (GLFC 1970b). Spawning has occurred over sand and rock since 1963 at Kelty Point, Indian Point (45°46', 85°34'), and Stony Point (45°44', 85°30'), and since the 1930s in Sandy Bay (45°41', 85°30') (Organ et al. 1978).

Garden Island (45°48', 85°30'). Since 1961, spawning has occurred over rock on all the shoals around Garden Island, including Garden Island Shoal (45°52', 85°29'), Whiskey (45°49', 85°37'), Squaw (45°50', 85°35'), Pismire (45°46', 85°27'), and Grape (45°47', 85°25') islands and their shoal areas (Organ et al. 1978).

Hog Island (45°47', 85°22'). Since the 1920s, spawning has occurred over rock and gravel on all the shoals around Hog Island, including Hog Island Reef (45°44', 85°21') and Hat Island (45°49', 85°18') (Organ et al. 1978). Spawning usually occurred in this area from late November to late December (Van Oosten 1927a), but some times spawning began in late October (Koelz 1929). In 1970, ripe fish were collected from reefs (45°50', 85°23') on the north side of Hog Island (GLFC 1970b).

Mille Coquins Reefs (46°00', 85°27'), Outer Reef (45°58', 85°27'), and Potter Reef (46°00', 85°32'). Lake whitefish spawned here over rock and gravel in November (Organ et al. 1978; Van Oosten 1927a).

Fagan Reef (45°57', 85°18'). Spawning occurred here during November (Organ et al. 1978; Van Oosten 1927a).

Five Mile Reef, Metty's Point Grounds, and Metty Outer Reef (locations unknown). Spawning occurred here in November (Van Oosten 1927a).

Grays Reef (45°47', 85°14'). Since 1961, spawning has occurred here over rock and gravel (Organ et al. 1978).

Simmons Reef (45°55', 85°12'). Lake whitefish spawned here (no dates given) over rock (Organ et al. 1978).

Manitou Paymen Shoal (45°58', 85°04'). In 1935-36, lake whitefish spawned here over rock substrate at depths of 6 to 30 ft (Organ et al. 1978).

Sturgeon Bay (45°43', 84°58'). As early as 1927-30, spawning occurred in the bay, mainly over rock, gravel, and sand in 6-60 ft of water (Organ et al. 1978).

Cross Village (45°39', 85°03'). In 1866, a large catch of lake whitefish was made in November in an area (precise location unknown) 1 mi S of the village in 20 ft of water (Smith and Snell 1891).

Ile aux Galets (45°41', 85°10'). Spawning occurs here over rocky substrate at depths of 6-30 ft (Organ et al. 1978).

Dahlia Shoal (45°38', 85°12'). Spawning occurs over honeycombed limestone in water as deep as 30 ft (Organ et al. 1978).

St. Helena Shoal (45°52', 84°55'). Lake whitefish spawn over rocky substrate here in water about 6-30 ft deep in November and December. Spawning was reported here as early as the mid-1920s, and again in the 1960s and 1970s (Organ et al. 1978; Van Oosten 1927a).

Charlevoix (45°19', 85°15'). Lake whitefish larvae hatched in this area in the spring (Ward 1896).

Fox Islands (45°27', 85°50'). Spawning occurred on the large area of reefs and shoals around the islands (Koelz 1929, MSBFC 1890) during a 2-week period in mid-November to January (Van Oosten 1927a, 1936c). Lake whitefish spawned during the 1930s over rock around North Fox Island (45°29', 85°47'), from 1915 to the 1970s over gravel around South Fox Island (45°25', 85°51'), and from 1915 to the 1960s over gravel on the South Fox Island Shoals (45°18', 85°51') (Organ et al. 1978).

MM-4

Grand Traverse Bay (45°05', 85°30'). The west arm of the bay was a favorite spawning ground for lake whitefish (MSBFC 1895), but the beds became covered by sawdust and sawmill waste, and the fish were driven away (MSBFC 1888, 1895). In 1897, spawn of whitefish or lake trout, or both, were collected from a tributary (location unknown) of the bay (Ravenel 1898).

> Antrim Creek (45°10', 85°23'). Until 1950, spawning occurred at the creek mouth (Organ et al. 1978).
>
> Grand Traverse Shoal (45°08', 85°26') (Price and Kelly 1976). In the 1920s, spawning occurred here from November 25 to December 10 (Van Oosten 1927a).
>
> Elk River (44°54', 85°25'). Historically, a spawning run of lake whitefish entered the river; in 1851, a sawmill and dam was built which blocked the run (Price and Kelly 1976).
>
> Old Mission Point (45°00', 85°29'). Historically, spawning occurred on the extensive shoal area at the point over coarse gravel and porous rock (MSBFC 1895; Koelz 1929). Spawning occurred on Old Mission Point Shoal (45°01', 85°29') from November 25 to December 10 and on Old Mission Point Reef (45°02', 85°29') during December 1 to 15 (Organ et al. 1978; Van Oosten 1927a); spawning in the area occurred about 2 weeks later than at Lighthouse Point (45°13', 85°33') (Koelz 1929).
>
> Deepwater Point (44°47', 85°31'). Spawning occurs on the rocky shoreline north of the point (Price and Kelly 1976).
>
> Merril Point (44°58', 85°31'). Since 1935, spawning has occurred here over rock (Organ et al. 1978).
>
> Tucker Point (44°54', 85°34'). Spawning occurred later here than at Mission Point (45°00', 85°29') (Koelz 1929).
>
> Traverse City (44°46', 85°37'). A spawning run of lake whitefish entered Kid's Creek (44°46', 85°38'); in 1847, a dam was erected on the creek which blocked the run (Price and Kelly 1976).

Lee's Reef (44°54', 85°37'). Since 1936, spawning has occurred here over honeycombed rock and moss (Organ et al. 1978; Price and Kelly 1976).

Suttons Point (45°00', 85°36')--Lee Point (44°56', 85°36'). Spawning occurs at Suttons Point over rock. During 1935-68, spawning occurred over sand and gravel along shore from Suttons Point to Lee Point (Organ et al. 1978).

New Mission Bay (45°02', 85°35'). Since 1958, spawning has occurred at 45°02', 85°35' over sand and rock (Organ et al. 1978).

Northport Bay (45°07', 85°35'). Since 1958, spawning has occurred over rock and sand along shore in an area (45°05', 85°35') about 1 mi S of Timber Shores Resort (45°06', 85°36') (Organ et al. 1978).

Bellow Island (45°06', 85°34'). Since 1935, spawning has occurred over rock around the island and over the reefs (45°07', 85°34') north of the island (Organ et al. 1978).

Lighthouse Point (45°13', 85°33'). This was historically one of the greatest lake whitefish spawning grounds in Lake Michigan (Koelz 1929; Kumlein and True 1887), spawning occurred over the reef and shoals from November 25 to December 15 (Van Oosten 1927a). Since 1958, spawning has occurred over rock and sand at the point and in an area (45°11', 85°28'--45°14', 85°29') about 4 mi E of the point; since 1935, lake whitefish have spawned over rock, moss, and mud on a reef (45°11', 85°31') about half-way to Northport Point (Organ et al. 1978).

Raft's Camp (location unknown). Spawning occurs here on rocky reefs (Price and Kelly 1976).

MM-5

Cat Head Point (45°11', 85°37'). In the 1920s, spawning occurred here from November 25 to December 10 (Van Oosten 1927a).

Leland (45°01', 85°46'). Historically, spawning occurred off Leland (MSBFC 1890); the specific location was not given.

Good Harbor Bay (44°58', 85°50'). Since 1954, lake whitefish have spawned over rock and sand at Pyramid Point (44°58', 85°56'); from 1925 to 1940, spawning also occurred over the rock reef (44°59', 85°49') in the bay (Organ et al. 1978).

North Manitou Shoals (45°02', 85°58'). In the 1930s, spawning occurred here over gravel (Organ et al. 1978).

North Manitou Island (45°07', 86°01'). From 1925 to 1940, spawning occurred around the entire island over gravel and rock substrate (Organ et al. 1978). During the 1920s, spawning occurred here from November 25 to December 15 (Van Oosten 1927a).

South Manitou Island (45°01', 86°08'). Historically, spawning occurred on the rocky reef (45°03', 86°09') off the northwest corner of the island (MSBFC 1890). From 1915 to the 1960s, spawning occurred all around the island (Organ et al. 1978). During the 1920s, spawning occurred here from November 15 to December 16 (Van Oosten 1927a).

Platte Bay (44°45', 86°07'). Lake whitefish spawned (no dates given) over the rock reef (44°44', 86°09') at the mouth of the Platte River (Organ et al. 1978) and over rocks (precise location unknown) off Empire (44°49', 86°04') (MSBFC 1890). In the 1920s, spawning at Empire occurred from November 25 to December 15 (Van Oosten 1927a).

Frankfort (44°38', 86°14'). Historically, spawning occurred off Frankfort (MSBFC 1890); the specific location was not given.

MM-6

Arcadia (44°30', 86°14'). Since the 1930s, spawning has occurred on a rock reef (44°28', 86°16') along shore south of Arcadia (Organ et al. 1978).

Portage Lake (44°22', 86°14'). Since the 1930s, spawning has occurred on a small rock reef (44°22', 86°17') in 30 ft of water (Organ et al. 1978).

Bar Lake (44°18', 86°18'). Since the 1930s, lake whitefish have spawned in an area extending about 2 mi S from Bar Lake over rock (Organ et al. 1978).

Manistee (44°15', 86°20')--Little Sable Point (43°39', 86°33'). From the 1930s to 1978, lake whitefish spawned along this entire shoreline over rock, gravel, and clay, usually at water depths less than 60 ft (Organ et al. 1978).

> Manistee. Historically, whitefish were driven away from the Manistee area by sawdust and other sawmill waste (MSBFC 1888).
>
> Ludington (43°57', 86°28'). In 1890, spawning was believed to occur on clay banks (precise location unknown) in the Ludington area about 8 mi N of Pentwater (43°47', 86°26') (MSBFC 1890). At this time, lake whitefish were reportedly being driven away from the area by sawdust and other sawmill wastes (MSBFC 1888, 1893, 1895). In the 1920s, lake whitefish spawned on small rock patches (precise location unknown) 6 mi S of Ludington and on the "Ludington Clay Banks" (precise location unknown) from mid-November to mid-December (Van Oosten 1927a). Spawning lake whitefish appear at the Ludington Pumped Storage Plant (43°54', 86°27') beginning about the last week of October; abundance peaks during the second and third week of November and remains high until early December. Spawning occurs in an area (43°52', 86°27'--43°55', 86°27') surrounding the intake of the plant, at

depths less than 30 ft (Brazo, pers. comm. 1979). Many lake whitefish spawn along the rock jetties of the plant, especially along the west breakwall. Large numbers of ripe adults have been collected in the area (Brazo, pers. comm. 1979; Brazo and Liston 1977). In 1971, many ripe fish were collected about 2 mi offshore from the plant intake in mid-November (Consumers Power 1972). Lake whitefish larvae are collected near the plant from mid-April to early May (Brazo, pers. comm. 1979; Liston et al. 1978); large numbers of larvae are found between the shoreline and the 5 ft depth contour. Young-of-the-year are found between the 5 and 15 ft depth contours, mainly just north of the plant (Brazo, pers. comm. 1979).

MM-7

Stony Lake (43°34', 86°30')--Duck Lake (43°20', 86°24'). In the late 1800s and early 1900s, lake whitefish were being driven away from the White Lake area (43°23', 86°26') by sawdust and paper mill waste (MSBFC 1888, 1895). Commercial fishermen report that lake whitefish spawned from the 1920s to 1978 in most areas along the shoreline from about 4 mi N of Stony Lake to 2 mi S of Duck Lake over rock, gravel, clay, and sand (Organ et al. 1978). A rather isolated population of lake whitefish exists in the east-central part of Lake Michigan proper, and at least one fisherman believes that this population spawns on a clay bottom area near White Lake. The nursery area for this population probably extends from Saugatuck (42°40', 86°12') to Pentwater (43°47', 86°26') (Wells, pers. comm. 1979).

Muskegon (43°13', 86°17'). By the late 1800s, lake whitefish were reported to have been driven away from the Muskegon area by the great quantities of sawdust and edging wastes from the sawmills on the Muskegon River (43°14', 86°15') (MSBFC 1887, 1888, 1893, 1895). From 1932 to 1978, lake whitefish spawned in an area (43°14', 86°21'--43°11', 86°19') extending south from the mouth of the Muskegon River for about 3 mi; spawning occurred over sand in water about 12-30 ft deep (Organ et al. 1978).

Little Black Lake (43°07', 86°17')--Lake Macatawa (42°46', 86°13'). From 1930 to 1975, lake whitefish spawned in this area over sand in water about 12-70 ft deep (Organ et al. 1978).

Grand Haven (43°04', 86°13'). Lake whitefish spawned about 4 mi S of the mouth of the Grand River (43°03', 86°15'); a single catch of 1,100 lbs of lake whitefish was made there on November 9, 1893 (MSBFC 1895). In the late 1800s, lake whitefish were reportedly being driven away from the Grand Haven area by sawdust and sawmill waste (MSBFC 1888).

Little Pigeon (Pine) Creek (42°58', 86°13'). In 1980, lake whitefish fry were collected at the creek mouth in March (Gulvas, pers. comm. 1980).

Port Sheldon (42°54', 86°13'). In 1978 and 1980, a few larvae, believed to be lake whitefish, were present in samples collected at the Campbell Power Plant (45°55', 86°12') in April and May (Jude et al. 1979a; Jude and Auer, pers. comm. 1980).

MM-8

Lake whitefish probably spawn in small numbers in suitable areas all along the southeast shore (Wells et al. 1971), and presumably the entire shoreline (41°46', 86°49'--42°46', 86°12') bordering Allegan, Van Buren, and Berrien counties is a nursery ground (Wells 1972).

Lake Macatawa (42°46', 86°13')--Kalamazoo River (42°40', 86°13'). In 1946-75, spawning occurred throughout the area, over rock and sand, from the shoreline out to a water depth of 50 ft (Organ et al. 1978).

Saugatuck (42°40', 86°12'). In the 1880s, Honey Comb Reef (42°39', 86°15'--42°36', 86°15'), about 1 mi SW of the mouth of the Kalamazoo River (42°40', 86°13'), was a good spawning ground for lake whitefish (Smith and Snell 1891). Spawning also occurred on a larger area of gravel and porous rock (precise location unknown) 4-6 mi SW of Saugatuck (MSBFC 1893). By 1890, no spawning had occurred at Saugatuck for 3-4 years (MSBFC 1890). In 1971, a few ripe adults were captured at Saugatuck Reef (Honey Comb Reef) in the fall (Wells 1972; Wells et al. 1971). Commercial fishermen reported that spawning occurred on the reef from 1934 to 1977 (Organ et al. 1978). The area near Saugatuck Reef may be one of the more important nursery areas along the southeast shore of Lake Michigan (Wells 1972).

Glenn (42°31', 86°14'). Lake whitefish spawn in an offshore area (42°29', 86°20') about 2 mi S of Glenn over rock at depths of about 75-100 ft (Organ et al. 1978).

South Haven (42°24', 86°17'). Historically, lake whitefish did not spawn near South Haven (MSBFC 1890). Presently, spawning occurs along shore from the Palisades Power Plant (42°19', 86°19') north to South Haven over sand and rock at depths of about 18-70 ft (Organ et al. 1978).

St. Joseph (42°06', 86°29'). Prior to 1890, spawning occurred 8 mi SW of St. Joseph (MSBFC 1890). It was reported earlier that lake whitefish were being driven away from the area by sawdust and sawmill waste (MSBFC 1888).

Warren Dunes State Park (41°54', 86°37')--Grand Beach (41°46', 86°49'). Lake whitefish spawn along this shoreline to depths of about 40 ft. During 1945-68, they also spawned in an area (41°49', 86°51') off Grand Beach at depths of about 50-60 ft (Organ et al. 1978). In the late 1930s, ripe-running fish were captured in late fall in a reef area (41°48', 86°59') about 10 mi W of Grand Beach at depths greater than 80 ft (Westerman, pers. comm. 1979). Spawning also occurs on the clay reef (41°52', 86°42') off Lakeside (41°51', 86°40'), and the area near the reef may be one of the more important nursery grounds along the southeast shore of Lake Michigan (Wells 1972).

BLOATER

In recent years, the chub population in Lake Michigan has been composed mainly of bloaters (Becker 1976). The bloater is generally common in Lake Michigan but is declining in some areas (Todd, pers. comm. 1981). The bloater spawns pelagically in the open lake at depths of about 198-396 ft, but usually at depths greater than about 240 ft; spawning occurs from January to March, and usually peaks in February (Brown, pers. comm. 1979; Daly et al. 1975; Emery and Brown 1978; Hile, pers. comm. 1979; Jobes 1949b; Koelz 1929; Lagler 1948; Walburg 1973; Wells 1980). A few spent adults have been collected as early as August (Jobes 1949b; WDNR 1974); most females are spent by April (Daly et al. 1975). The bloater probably spawned in deep water throughout the lake off most of the shipping ports (Koelz 1929) and used the entire pelagic zone of the lake as a nursery ground (Wells, pers. comm. 1979); most young-of-the-year (YOY) are found at mid-water (Brown and Wells 1976).

Wisconsin

WM-3

North Bay (45°09', 87°04'), Moonlight Bay (45°05', 87°05'), and Baileys Harbor (45°03', 87°07'). Larvae were seen here just after ice break-up in 1978 and 1979 (Copes, pers. comm. 1979).

WM-4

Kewaunee Power Plant (44°21', 87°32'). Coregonine larvae, presumed to be bloaters, were entrained at the plant (CDM/Limnetics 1977).

WM-5

Pigeon River (43°47', 87°43'). A few YOY about 3 in. long were collected just north of the mouth of the Pigeon River over clay substrate with cobbles and a few boulders to a depth of about 24 ft (LaJeone, pers. comm. 1979).

Port Washington (43°23', 87°52'). Spawning occurred off this port, and many ripe bloaters were caught in shallow water (Koelz 1929). Coregonine larvae, presumed to be bloaters, were entrained at the Port Washington Power Plant (43°23', 87°52') (CMD/Limnetics 1977).

Milwaukee (43°02', 87°54'). In 1919, spawning occurred off Milwaukee; spent and ripe fish were caught here in 300 ft of water in late March (Koelz 1929). In 1974-75, eggs were collected during the winter in about 190 ft of water at approximately 43°00', 87°40' (Norden, pers. comm. 1979). In 1976, larvae were hatched from eggs stripped from ripe adults taken on Milwaukee Reef (42°59', 87°05'--43°11', 87°20') in early March (Janssen, pers. comm. 1979).

MM-8

Along the southeast shoreline of Lake Michigan, spawning or nursery grounds are rarely found in water less than 120 ft deep (Wells 1972).

Holland (42°47', 86°07')--South Haven (42°24', 86°17'). A commercial fisherman reported that spawning occurred in an area extending from the MM-7 district boundary at Holland to 4 mi W of South Haven. Spawning occurs over mud, sand, and clay at depths of 120-360 ft in late December to March (Organ et al. 1978). In 1964, bloaters began hatching in the Saugatuck area (42°40', 86°12') in early April, and peak hatching occurred in mid-June. Maximum numbers of larvae were collected in late June and early July, and densities rapidly declined to zero in mid-October. Most larvae were found near bottom in deep water. The highest densities were in 300-360 ft of water; 83% of all larvae were found at depths of 240-360 ft, and 96% of the bloater larvae were taken in water where the temperature did not exceed about 41°F (Wells 1966).

Bridgman (41°56', 86°35'). In 1921, spawning and nearly ripe fish were collected approximately 21 mi W (41°55', 87°00') and 30 mi W (41°59', 87°08') of Bridgman, in 168 and 180 ft of water respectively, in early March (Koelz 1929). Spawning is believed to occur in the winter (Jude, pers. comm. 1979) in deep water at unknown locations (Jude et al. 1975). Young-of-the-year were collected at depths of 20 and 30 ft in late fall (Jude et al. 1979b). Unidentified coregonine larvae, presumed to be bloaters, have been collected during April and May at depths of 70 ft. Since 1977, many YOY have been collected here; this is probably a nursery area for larger YOY (Jude and Thurber, pers. comm. 1979).

DEEPWATER CISCO

The deepwater cisco is believed to be extinct in Lake Michigan (Todd, pers. comm. 1981). The last recorded capture in Lake Michigan occurred in Grand Traverse Bay, Michigan, in June 1951 (Todd 1978). This species spawned in August and September in Lake Michigan (Koelz 1929).

Wisconsin

WM-2

Rock Island (45°25', 86°49'). In 1920, mature males with pearl organs were taken at depths of 420-546 ft off Rock Island in mid-August (Koelz 1929).

WM-6

Kenosha (42°35', 87°49'). Spawning occurred off Kenosha (Brown 1970a), and in 1969 eggs were collected from ripe adults captured 4 mi E of Kenosha in February (Edsall, Rottiers, and Brown 1970).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In August and September 1978, many YOY were found near the Waukegan Generating Station (42°23', 87°49') over a substrate of fine sand with a few rocks at depths of 30 ft or less; YOY were particularly abundant at the Wisconsin-Illinois border (42°29', 87°48') (LaJeone, pers. comm. 1979).

Michigan

MM-2

Point Aux Barques (45°48', 86°21'). Spawning occurred in the spring, over mud, in water 300-360 ft deep about 15 mi SSE of Point Aux Barques (Organ et al. 1978).

MM-3

Big Rock Point (45°22', 85°12'). Coregonine larvae, presumed to be bloaters, were entrained at the Big Rock Power Plant (45°22', 85°12') (CDM/Limnetics 1977).

MM-7

Duck Lake (43°20', 86°24')--Holland (42°47', 86°07'). A commercial fisherman reported that spawning occurred in an area extending from about 8 mi W of Duck Lake south to the MM-8 district boundary at Holland. Spawning occurs over mud, sand, and clay at depths of 120-360 ft in late December to March (Organ et al. 1978). In 1919, spent and ripe fish were caught at a location 12 mi W of Grand Haven (43°04', 86°13') in 300-330 ft of water on March 20 (Koelz 1929). Bloaters probably spawn in the deeper waters off Port Sheldon (42°54', 86°13') (Jude et al. 1978, 1979a; Jude, pers. comm. 1979). Collections of YOY in the fall indicated that significant spawning had occurred somewhere in the area earlier in the year (Jude et al. 1978, 1979a). Three ripe females and one ripe male were collected in June and July in shallow water. One larva was found on June 18 in 50 ft of water about 2 mi S of Port Sheldon (Jude et al. 1978). A few larvae, believed to be bloaters, were collected in June 1977 and 1978 and in July and August 1980 (Jude and Auer, pers. comm. 1980).

KIYI

The kiyi is believed to be extinct in Lake Michigan (Todd, pers. comm. 1981). The last reported capture of kiyi in Lake Michigan occurred near Milwaukee, Wisconsin, on September 11, 1974 (Todd 1978). In Lake Michigan, kiyi spawned from late September through at least mid-November, and peak spawning usually occurred from mid-October to early November (Hile and Deason 1947; Lagler 1948). Kiyi spawned at depths of approximately 300-540 ft (Hile, pers. comm. 1979; Hile and Deason 1947). Spawning may have occurred in all areas of the lake at suitable depths (Hile and Deason 1947). The spawning substrate was typically mud (Hile, pers. comm. 1979). The following locations were identified as spawning grounds based on collections of ripe and spent fish.

Wisconsin

WM-4

Kewaunee (44°27', 87°30'). Spawning occurred here in October (Deason and Hile 1947). In 1931, spawning occurred at a location (44°25', 87°15') 7-12 mi off Kewaunee in 438-558 ft of water, from at least October 15 to November 5 (Hile and Deason 1947).

WM-5

Sheboygan (43°45', 87°42'). In 1931, spawning fish were collected at a location (43°40', 87°28') about 13 mi off Sheboygan, in 426 ft of water from late October to mid-November (Hile and Deason 1947).

WM-6

Racine (42°44', 87°47'). A spawning run occurred here in October (Deason and Hile 1947). In 1931, ripe and spent fish were collected at a location about 22 mi off Racine at a depth of 360 ft, from late September to late October (Hile and Deason 1947).

Indiana

Michigan City (41°43', 86°54'). In 1920, two pearled males were caught here on October 11, and a spent female and many fish that had not yet spawned were collected on November 8 (Koelz 1929).

Michigan

MM-5

Frankfort (44°38', 86°14'). In 1929, spawning kiyi were taken in October on the "northwest shoal" (44°45', 86°26') about 12 mi NW of Frankfort, at a depth of 420 ft (Koelz 1929). Large numbers of fish were also caught during the spawning season in an area (44°35', 86°20') about 5 mi off Frankfort at a depth of about 474 ft (Hile and Deason 1947).

MM-6

Ludington (43°57', 86°28'). Many fish were caught during the spawning season (about October 1) at a location (43°56', 86°40') off Ludington at a depth of 366 ft; although the gonads of the fish were not examined, the large catch indicated that this was probably a spawning ground (Hile and Deason 1947).

MM-7

Muskegon (43°13', 86°17'). In 1931, ripe and spent fish were collected about 11 mi WSW of Muskegon at approximately 43°10', 86°34' in 348 ft of water on September 29 (Hile and Deason 1947).

BLACKFIN CISCO

The blackfin cisco is believed to be extinct in all the Great Lakes (Todd, pers. comm. 1981). The last recorded capture of blackfin cisco in Lake Michigan occurred at Marinette, Wisconsin, on May 26, 1969 (Todd 1978). The blackfin cisco spawned on stony substrate (Smith and Snell 1891) between October and March, primarily in December and January (Koelz 1929; MSBFC 1887; Smith and Snell 1891). The blackfin cisco did not move to shoal water to spawn (MSBFC 1887).

Wisconsin

WM-6

Racine (42°44', 87°47'). Spawning occurred at an unnamed location (42°43', 87°10') about 30 mi E of Racine, in 360-540 ft of water, from late December to early January (Koelz 1929).

Michigan

MM-1

Escanaba (45°45', 87°04'). A run evidently occurred in Little Bay de Noc (45°45', 87°00'); fish generally were not found in the bay until mid-October, after which they constituted a large part of the catch (Smith and Snell 1891).

MM-4

Grand Traverse Bay (45°05', 85°30'). Many blackfin ciscoes spawned here over mud and clay bottom in 90-180 ft of water in late fall and winter (Smith and Snell 1891).

MM-6

Manistee (44°15', 86°20'). Spawning occurred at an unnamed area (44°14', 86°30'--44°14', 86°27') 5-8 mi W of Manistee on clay in 240-480 ft of water from late December to early January (Koelz 1929). They first appeared in the area on about November 1 and increased to peak abundance in December. Most fishing was carried out at depths of 360-480 ft. In the spring, the fish moved back to water 600-660 ft deep (Smith and Snell 1891).

MM-8

Saugatuck (42°40', 86°12'). Spawning occurred at an unnamed area (42°42', 86°44'--42°42', 86°50') 25-30 mi W of Saugatuck over mud in 360-480 ft of water (Organ et al. 1978).

SHORTNOSE CISCO

This species is believed to be extinct in Lake Michigan (Todd, pers. comm. 1981). The last recorded capture of the shortnose cisco in Lake Michigan occurred near Ludington, Michigan, on May 18, 1972 (Todd 1978). In Lake Michigan, the shortnose cisco generally spawned from April through June, but some spawning did not occur until September (Brown, pers. comm. 1979; Jobes 1943; Koelz 1929; Lagler 1948). Two ripe adults were collected in May during the late 1960s (Brown, pers. comm. 1979). The location of spawning grounds was deduced from catches of ripe and spent adults. During the spawning season, the shortnose cisco was found at depths of 72-582 ft, but usually at 120-474 ft in lower Lake Michigan, 180-354 ft in the upper lake, and less than 150 ft in Green Bay (45°05', 87°25') (Jobes 1943). Spawning occurred at water temperatures of 39-40°F over a wide variety of substrates, including clay, silt, sand, and muddy sand (Jobes 1943; Koelz 1929). The following areas were spawning grounds.

Wisconsin

WM-1

Sturgeon Bay (44°53', 87°24') (Koelz 1929).

WM-2

Washington Island (45°23', 86°54'). East of the island (Jobes 1943).

WM-4

Algoma (44°37', 87°26') (Koelz 1949).

WM-5

Sheboygan (43°45', 87°42'). In 1931, a spawning run occurred in early May at depths of 330-390 ft (Jobes 1943).

Port Washington (43°23', 87°52'). In 1921, a heavy run was reported 3-4 mi ENE of Port Washington (43°24', 87°46') over muddy sand at depths of 84-210 ft; spawning began in the last week of April and continued until mid-June (Koelz 1929).

Milwaukee (43°02', 87°54') (Koelz 1929).

WM-6

Racine (42°44', 87°47'). In 1931, a run occurred at depths of 216-240 ft in late May (Jobes 1943).

Indiana

Michigan City (41°43', 86°54') (Koelz 1929).

Michigan

MM-2

Manistique (45°57', 86°15') (Jobes 1943).

MM-3

Charlevoix (45°19', 85°15') (Jobes 1943).

MM-4

Northport (45°08', 85°37') (Koelz 1929).

MM-6

Ludington (43°57', 86°28'). In 1931, runs occurred at depths of 180-204 ft and 450-480 ft from mid-may to late June (Jobes 1943). In 1972, a few spent males with spawning tubercles were collected at Ludington on May 18 (Brown, pers. comm. 1979; Todd, pers. com. 1981).

MM-7

Grand Haven (43°04', 86°13'). In 1931, runs occurred at depths of 168-192 ft and 300-342 ft in late May and early June (Jobes 1943).

MM-8

St. Joseph (42°06', 86°29'). In 1931, runs occurred at depths of 180-198 ft and 282-288 ft in mid- to late May (Jobes 1943).

SHORTJAW CISCO

This species is believed to be extinct in Lake Michigan (Todd, pers. comm. 1981). The last recorded capture in Lake Michigan occurred at Racine, Wisconsin, on September 23, 1975 (Todd 1978). The shortjaw cisco is now considered to be taxonomically synonymous with the longjaw cisco (Todd and Smith, unpubl. data). In Lake Michigan, the shortjaw cisco spawned over a period of about 2 weeks in October or November (Koelz 1929). All of the known spawning grounds were in 60-180 ft of water and had sand and clay substrate (Koelz 1929). Fishermen reported that the depth of spawning varied with weather conditions; in calm weather, the fish spawned in shallower water. The entire area between Port Washington (43°23', 87°52') and Grand Haven (43°04', 86°13') was believed to have been a spawning area (Koelz 1929). Spawning occurred off the following ports.

Wisconsin

WM-5

Port Washington (43°23', 87°52') and Milwaukee (43°02', 87°54') (Koelz 1929).

Indiana

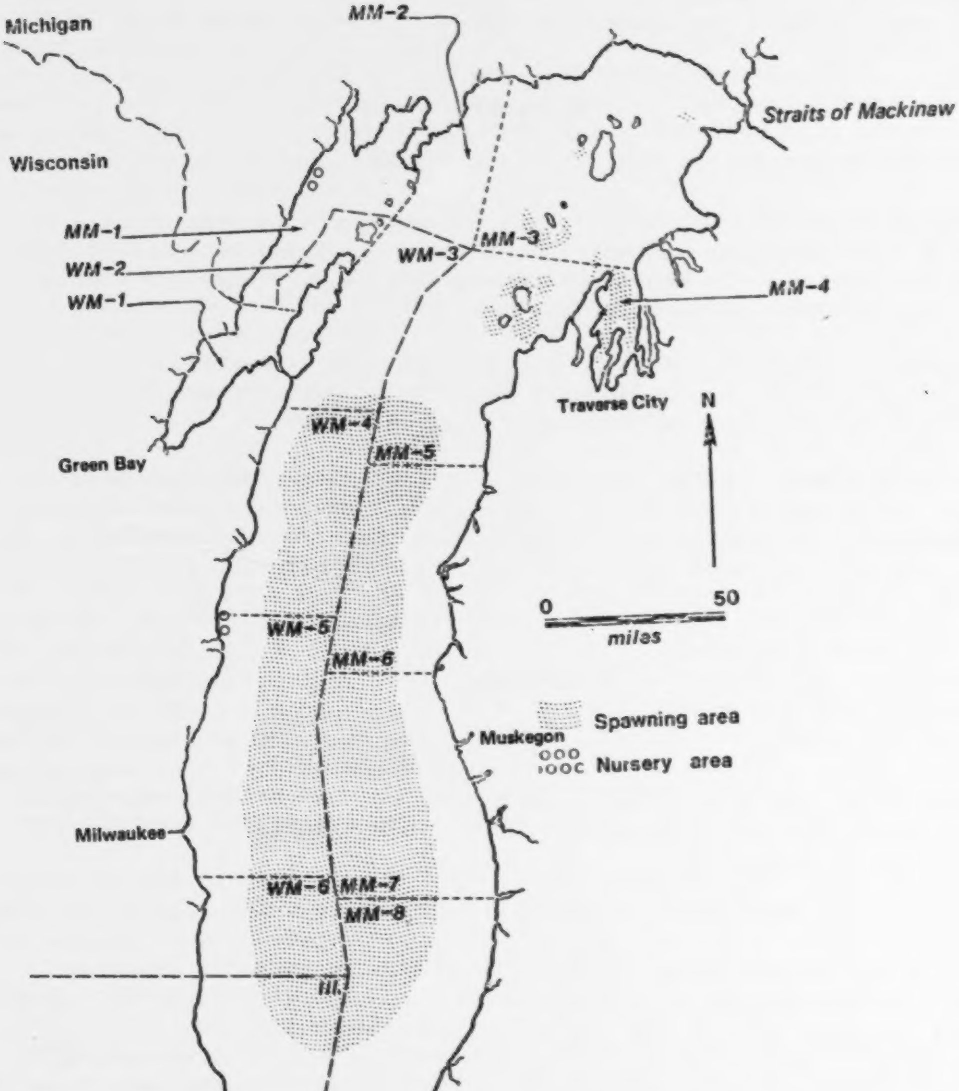
Michigan City (41°43', 86°54') (Koelz 1929).

Michigan

MM-7

Grand Haven (43°04', 86°13') (Koelz 1929).

COREGONUS spp.


Michigan
MM-2
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Most commercial fishermen do not distinguish among the several species of chubs found in their nets. Areas used by chubs for spawning are difficult to identify precisely because the fishermen often describe large general areas that include a wide range of depths. One fisherman identified the chub spawning areas as being any locations with pea-sized gravel, usually where the waters are 180-300 ft deep (Organ et al. 1978).

Wisconsin

WM-5

Pigeon River (43°47', 87°43'). A few young-of-the-year about 3 in. long were collected near the mouth of the river. These were either lake herring or bloater. The substrate in the area is hard clay and cobble with a few boulders (LaJeone, pers. comm. 1979).

Sheboygan (43°45', 87°42'). In 1977, one early postlarva of an unidentified coregonine was captured near the Edgewater Power Plant (43°43', 87°42') in late July (Swanson Environ. 1979).

Milwaukee Reef (42°59', 87°05'--43°11', 87°20')--Sheboygan Reef (43°14', 87°10'--43°27', 87°10'). Until about 1958, this area supported chub spawning. The substrate was clay, mud, some rock, honeycombed rock, and "clinkers" (combusted coal waste) at depths of 252-480 ft (Organ et al. 1978).

Michigan

MM-1

Bark River (45°34', 87°14'). Larvae of an unidentified coregonine were collected off the mouth of the river in late April to late May (Wis. Elec. Power, unpubl. data).

MM-3

South Fox Island Shoals (45°18', 85°51'). In 1954-78, spawning ocurred over mud bottom in an area (45°20', 85°48'--45°15', 85°50') about 2 mi off the east side of the shoals; in a V-shaped area (45°15', 85°54'--45°13', 85°52' and 45°15', 85°50'--45°13', 85°52') extending south; in a V-shaped area (45°17', 85°59') about 6 mi to the west, and in a strip about 15 mi W of the shoals (Organ et al. 1978).

High Island (45°44', 85°40'). Spawning occurs in an area (45°43', 85°45'--45°39', 85°45') between High Island, Gull Island Reef (45°38', 85°48'), and Beaver Island (45°40', 85°33'); spawning takes place over clay, mud, and rock in November and December (Organ et al. 1978).

Simmons Reef (45°55', 85°12'). Spawning occurs just south of the reef (Organ et al. 1978).

Cat Head Reef (45°18', 85°33'). Fishermen have identified the area (45°17', 85°35'--45°14', 85°35') southwest of the reef as a spawning area (Organ et al. 1978).

MM-4

Grand Traverse Bay (45°05', 85°30'). In about 1869, an unidentified chub spawned along the shores of the bay in November (Koelz 1929). Between 1935 and 1968, spawning occurred in most of the bay over mud, at depths of 240-600 ft, in November and December. Fishermen have identified the central portions of both the east and west arms of the bay as spawning areas (Organ et al. 1978).

MM-5

Manitou Islands (45°04', 86°03'). As early as 1916, spawning occurred in many areas around the islands over mud and sand, at depths of about 100-600 ft, from November to February. Areas identified include an area (45°09', 85°57') east of North Manitou Island at depths of 210-360 ft; an area (45°06', 85°48') 9 mi E of North Manitou at depths of 500-600 ft; an area (45°01', 85°55'--45°05', 85°51') over mud north of Pyramid Point Shoal (44°59', 85°55') a mud and sand strip (45°06', 86°06'--45°11', 86°02') about 1 mi off the northwest shore of North Manitou (45°07', 86°01'); a mud and sand area (45°03', 86°03'--44°59', 86°03') about 2 mi off the east shore of South Manitou Island; a large mud and sand area (44°57', 86°02') about 7 mi in diameter between South Manitou Island and Sleeping Bear Bay (44°55', 86°00'); and a mud strip (45°06', 86°16'--44°55', 86°18') about 12 mi long running north to south about 6 mi W of South Manitou Island (45°01', 86°08') at depths of 300-600 ft (Organ et al. 1978). In 1952, fry of either bloater or shortnose cisco were caught by dip net in open water at an unidentified location near North Manitou Island in late July (Smith 1954, 1956).

MM-6

Point Betsie (44°42', 86°15')--Stony Lake (43°34', 86°30'). Spawning occurred throughout this entire area, over mud at depths greater than 190 ft, in January to mid-February (Organ et al. 1978).

MM-7

Stony Lake (43°34', 86°30')--Holland (42°47', 86°07'). From the 1940s to 1970s, spawning occurred along this entire shoreline at depths greater than 180 ft, over mud, silt, sand, and clay, mainly in October and November (Organ et al. 1978).

MM-8

Holland (42°47', 86°07')--South Haven (42°24', 86°17'). From the 1940s to 1970s, spawning occurred along this entire shoreline at depths greater than 180 ft, over mud, silt, sand, and clay, mainly in October and November (Organ et al. 1978).

South Haven (42°24', 86°17')--Indiana state line (41°46', 86°49'). From the 1930s to 1960s, chubs spawned 10 mi offshore in waters deeper than 180 ft, over clay, mud, and silt during October and November (Organ et al. 1978).

PINK SALMON

Pink salmon were introduced into Lake Superior in 1956 (Parsons 1973). In 1973, the first pink salmon appeared in northern Lake Michigan, and spawning runs have since been observed in odd-numbered years (North Woods Call 19791). Adults usually spawn in streams at the first suitable gravel area upstream from the mouth, during September (Wagner 1974a, 1976b). Relatively small spawning runs have entered the following tributaries to Green Bay (45°05', 87°25') and northern Lake Michigan.

Wisconsin

WM-1

Menominee River (45°06', 87°35'). Spawning runs occur (North Woods Call 1979j).

MM-1

Cedar River (45°24', 87°21'). In 1977 and 1979 (North Woods Call 1979j; Wagner 1977, 1979).

Ford River (45°40', 87°08'). One adult was caught in 1973 (Wagner 1974a).

MM-2

Thompson Creek (45°54', 86°19'). In 1973 and 1977 (Wagner 1974a, 1977).

Manistique River (45°57', 86°15'). In 1973 (Wagner 1974a).

MM-3

Point Patterson Creek (45°58', 85°40'). In 1975 (Wagner 1976a,b).

Crow River (46°02', 85°36'). In 1975 and 1979 (Wagner 1976a,b, 1979).

Rock River (46°05', 85°32'). In 1975 and 1977 (Wagner 1976a,b, 1977).

Black River (46°06', 85°21'). In 1973, 1975, 1977, and 1979 (Wagner 1974a, 1976a,b, 1977, 1979).

Cut River (46°03', 85°07') and Hog Island Creek (46°04', 85°17'). In 1975 (Wagner 1976a,b).

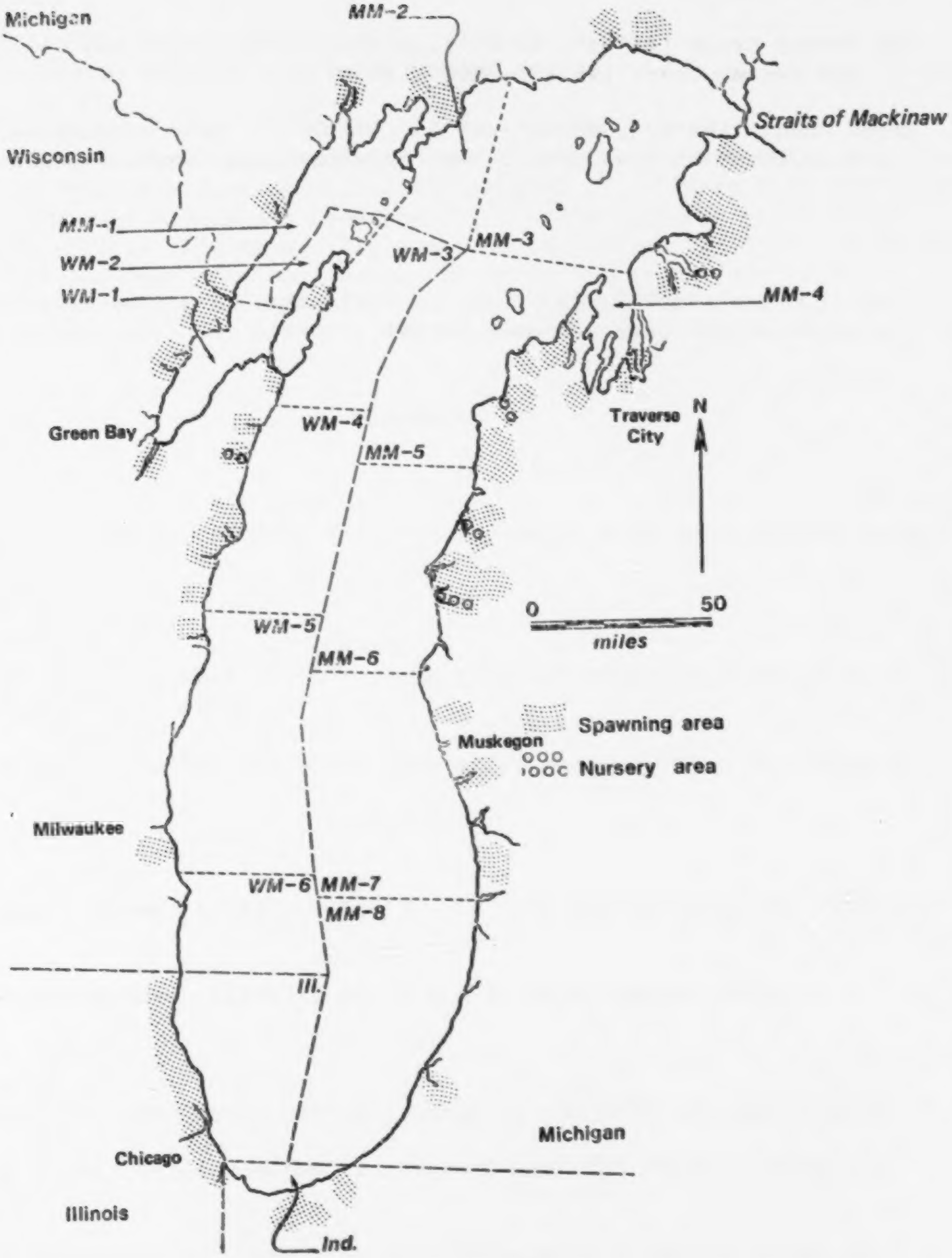
Big Sucker Creek (45°44', 84°57'), Little Sucker Creek (45°44', 84°57'), and Wycamp Creek (45°39', 85°01). In 1975 (Richey 1976).

Emmet County (45°47', 84°44'--45°22', 85°06'). Many streams in the county are believed to have pink salmon spawning runs (North Woods Call 1979j).

MM-5

Crystal River (44°55', 85°58'). In 1977, pink salmon were caught near the mouth of the river (Wagner 1978a).

COHO SALMON


Michigan
MM-2
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Green Bay
WM-4
MM-5
Traverse City
N
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Annual plantings of coho salmon in Lake Michigan since 1966 (Daly et al. 1975; GLFC 1973a,b, 1975, 1976, 1978; Parsons 1973; Wells and McLain 1973; WDNR, unpubl. data) have produced fall spawning runs in a number of Lake Michigan tributaries, and self-sustaining populations are established in some areas (Becker 1976; MDNR 1970; Taube 1974a). The first reported spawning runs of coho salmon from Lake Michigan occurred in the Big Manistee (44°15', 86°18') and Platte (44°44', 86°09') rivers in 1966 (MDNR 1970). Adults generally concentrate off stream mouths in late summer and early fall before entering streams to spawn; average bottom temperatures in the beach zones range from about 69°F in August to 58°F in September (GLFL 1970). Generally, spawning runs peak in September and October (Walburg 1973). Many Lake Michigan streams are not suitable for reproduction because of heavy siltation, a lack of gravel substrate, and poor water quality. About 2-8% of stocked fish are recovered in spawning migrations, and 95% of these are recovered in the streams in which they were released (Hasler et al. 1978).

Wisconsin

In Wisconsin tributaries of Lake Michigan, the most important factor restricting natural reproduction is the lack of suitable spawning substrate. Other limiting factors include prolonged cold water temperatures, unstable stream discharges, and superimposition of redds (Avery 1974).

WM-1

Coho salmon spawn in Green Bay (45°05', 87°25') tributaries in October and December (Belonger and Kernen, pers. comm. 1979). Stocked coho salmon spawn in the following tributaries.

Menominee River (45°06', 87°35'). Fall runs of stray fish occur (Belonger and Kernen, pers. comm. 1979).

Little River (45°03', 87°38') (Belonger and Kernen, pers. comm. 1979).

Peshtigo River (44°58', 87°39'). Fall runs of stray fish occur (Belonger and Kernen, pers. comm. 1979).

Oconto River (44°54', 87°50'). Fall runs of stray fish occur (Belonger and Kernen, pers comm. 1979; Carlson et al. 1977).

Pensaukee River (44°49', 87°54') and Fox River (44°32', 88°00). Fall runs of stray fish occur (Belonger and Kernen, pers. comm. 1979).

Sturgeon Bay (44°53', 87°24'). In 1973, fish tagged at Point Beach (44°17', 87°32') on October 24 were recaptured in Sturgeon Bay on October 30 (Spigarelli, unpubl. data). Coho salmon stocked as juveniles return to spawn in Strawberry Creek (44°49', 87°22') (Belonger and Kernen, pers. comm. 1979; MDNR 1970).

WM-3

Three Springs Creek (45°09', 87°04'). Spawning runs, redd building, and egg laying have been observed in this creek, which empties into North Bay (45°09', 87°04'). The stream bottom is sand, which silts over in the winter, and it is doubtful that successful natural reproduction occurs (Frederick, pers. comm. 1979).

Reiboldt Creek (45°06', 87°05') (MDNR 1970).

Woodard Creek (44°45', 87°20'). In 1974, fish tagged at Point Beach (44°17', 87°32') on October 16 were recaptured in Woodard Creek on November 26 (Spigarelli, unpubl. data).

WM-4

Ahnapee River (44°36', 87°26'). Stocked fish return to spawn here from October through December (Kernen, pers. comm. 1979).

Kewaunee River (44°28', 87°30'). Stocked fish return to spawn in the river from October through December (Kernen, pers. comm. 1979). Migrations of maturing coho salmon occur near the Kewaunee Power Plant (44°21', 87°32') (Spigarelli and Thommes 1976; Wis. Public Serv. Corp. 1971). A few ripe adults have been collected in the area near the plant when they congregate around river mouths. The substrate in this area is hard clay and cobble-size rock (LaJeone, pers. comm. 1979). Natural reproduction occurs in Little Scarboro Creek, a tributary of the Kewaunee River (Kernen, pers. comm. 1979). Spawning fish were observed in this creek in late October; many were present by the first week in November. The bottom type is mostly sand and gravel, and natural reproduction is severely limited by the high amount of fine substrate (Cloern 1973, 1976). Studies of Little Scarboro Creek from July 1971 to April 1973 revealed that mature coho salmon began to migrate into the creek in late October and spawning peaked in November. Water temperatures during the winter varied from 32 to 36°F, and eggs hatched in 145-150 days in early April. Young-of-the-year (YOY) averaged 3.6 in. in length by early September and began migrating downstream in August (Avery 1974; Cloern 1976).

Point Beach Power Plant (44°17', 87°32'). In 1971, large numbers of adult coho salmon appeared in the vicinity of the plant during the first week of September (Reed 1972). In 1976, the largest numbers of adults were caught in September and October (Spigarelli and Thommes 1976; Wis. Elec. Power and Wis.-Mich. Power, undated c).

East and West Twin Rivers (44°09, 87°34'). Stocked coho salmon return to spawn in both rivers from October to December (Hanson and Kernen, pers. comm. 1979). Catches in Two Rivers Harbor (44°09', 87°34') peaked in September prior to major fall spawning runs (Spigarelli and Thommes 1976).

Manitowoc (44°05', 87°39'). Both the Manitowoc (44°05', 87°39') and Little Manitowoc (44°06', 87°39') rivers have runs of stocked coho salmon from October to December (Hanson and Kernen, pers. comm. 1979).

Fischer Creek (43°56', 87°43'). Natural reproduction has occurred in this stream (Belonger and Kernen, pers. comm. 1979). Spawning runs begin in late October, and spawning peaks in November. In 1972, redds were observed on November 9. Water temperatures during the winter ranged from 30 to 35°F. Eggs collected from redds have hatched in 145-150 days in early April (Avery 1974, Cloern 1973, 1976). Substrate in the creek is muck and silt near the mouth and clay, rubble, and gravel in the upper reaches (Cloern 1973, 1976).

WM-5

Haven (43°51', 87°44'). Ripe adults moving inshore were collected over a hard clay and cobble rock substrate with scattered boulders. Adults congregate around the mouths of rivers and in rivers during October (LaJeone, pers. comm. 1979).

Sheboygan River (43°45', 87°42'). Coho salmon are found in the river into early winter (Swanson Environ. 1979).

Oak Creek (42°54', 87°51'). Spawning runs enter Oak Creek; fish also congregate in the area of the Oak Creek Power Plant (42°51', 87°50') during the fall (Limnetics 1974; Schultz et al. 1973; Wis. Elec. Power 1975b).

Illinois

Runs of stocked coho salmon enter all of the harbors along the shore (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°20', 87°50'). Ripe adults were collected in this area over a fine sand substrate with a few scattered rocks (LaJeone, pers. comm. 1979).

Indiana

Gary (41°37', 87°20'). In 1975, coho salmon collected at the Mitchell Power Station (41°38', 87°22') in November were in spawning condition (NALCO 1976a).

Burns Waterway (41°38', 87°10'). Stocked fish migrate into the Little Calumet River (41°37', 87°10') via the waterway to spawn during September to November (Koch, pers. comm. 1979). In 1969, natural reproduction was observed in the Little Calumet River in October and November (GLFC 1970b).

Bailly Generating Station (41°39', 87°07'). In 1974, two ripe males were collected in the immediate vicinity of the plant in September and October (Tex. Instrum. 1975b).

Trail Creek (41°44', 86°54'). Coho salmon spawn in Trail Creek from October to December (Koch, pers. comm. 1979). In 1969, natural reproduction was observed in Trail Creek in October and November (GLFC 1970b).

Michigan

By 1970, coho salmon had strayed extensively from the original planting sites, and relatively large spawning runs entered most of the Michigan tributaries of Lake Michigan (MDNR 1970; Parsons 1973).

MM-1

Cedar River (45°24', 87°21') (MDNR 1970).

Whitefish River (45°55', 86°57') (Parsons 1973). Some successful natural reproduction occurs (Becker 1976).

Fishdam River (45°54', 86°35'). Some successful natural reproduction occurs (Becker 1976).

MM-2

Bursaw Creek (45°50', 86°20') (MDNR 1970).

Thompson Creek (45°54', 86°19') (MDNR 1970; North Woods Call 1980a; Parsons 1973).

MM-3

Rock River (46°05', 85°32') (FWS 1979c).

Black River (46°06', 85°21'). Some natural reproduction occurs (Becker 1976).

Carp Lake River (45°45', 84°50'). In 1967, spawning runs entered the Carp Lake River (MDNR 1970).

Little Traverse Bay (45°24', 85°00'). Spawning runs enter the Bear River (45°23', 84°58'), Tannery Creek (45°23', 84°55'), Roaring Brook Creek (45°25', 84°56'), and Fivemile Creek (45°26', 85°02') (GLFC 1970b; MDNR 1970).

Lake Charlevoix (45°17', 85°10'). Spawning runs enter Porter (45°13', 85°04'), Page (Charlevoix County), Dyer (45°13', 85°04'), Horton (45°17', 85°05'), and Woods (45°19', 85°12') creeks and the Boyne River (45°13', 85°01') (MDNR 1970). A run also proceeds to the upper reaches of the Jordan River (45°09', 85°08') (Quick 1971). In 1978, fingerlings were found in the Boyne River (Galbraith 1978).

MM-4

Grand Traverse Bay (45°05', 85°30'). In 1967, Elk River (44°54', 85°25') and Yuba Creek (44°49', 85°28') had spawning runs (MDNR 1970). In 1968, spawning occurred in Brewery Creek (44°48', 85°38') (Parsons 1973).

MM-5

Leland (Carp) River (45°01', 85°46'), Good Harbor Creek (44°57', 85°49'), Shalda (Sucker) Creek (44°57', 85°53'), Crystal River (44°55', 85°58'), and Otter Creek (44°46', 86°04') (MDNR 1970).

Platte River (44°44', 86°09'). Stocked coho salmon returned to the Platte River to spawn (Hildebrand 1971; MDNR 1970; Parsons 1973, 1975; Reinert and Bergman 1974; Rybicki 1973; Rybicki and Keller 1976; Rybicki et al. 1975; Stauffer 1970, 1971, 1973; Taube 1969, 1971a,b, 1972, 1973, 1974a,c, 1975; Tody 1970). Spawning runs begin as early as mid-October and end as late as the end of January; runs peak anytime from October 25 to November 5 (Hildebrand 1971; MDNR 1970; Parsons 1975). In 1979, coho salmon schooled in Platte Bay (44°45', 86°07') in late August (Crowe 1979a). In 1970, coho salmon were collected on November 3 during the spawning run at a water temperature of 40-50°F (Stauffer 1971a). Successful natural reproduction has occurred every year since 1967 (Taube 1971b, 1972, 1973). Young remain in the Platte River for about one year and then migrate to the lake. Most return in about 18 months to spawn (Taube 1974a,c, 1975).

Betsie River (44°37', 86°13') (MDNR 1970). In 1979, coho salmon schooled off the mouth of the river in late August (Crowe 1979a).

Herring Creek (44°34', 86°13') and Arcadia Creek (44°29', 86°15') (MDNR 1970).

MM-6

Manistee (44°15', 86°20'). Stocked fish return to the Big Manistee (44°15', 86°18') and Little Manistee (44°13', 86°16') rivers to spawn (MDNR 1970; Parsons 1973; Rybicki 1973; Rybicki and Keller 1976; Tody 1970). Extensive spawning runs proceed up the Big Manistee River and enter Pine Creek; choice spawning areas here are used repeatedly throughout the spawning period that lasts at least 90 days (Merna 1979). In 1977-79, YOY were found in Pine Creek during early May to early June (Carl 1977, 1978, 1979). Runs peak in Bear Creek, a stocked tributary of the Big Manistee River, from late September to mid-October (MDNR 1970; Taube 1975). In 1979, coho salmon schooled in Lake Michigan off Manistee in August (Crowe 1979a).

Big Sable River (44°02', 86°30'). A spawning run enters this river (Rybicki 1973).

Ludington (43°57', 86°28'). In 1979, coho salmon schooled off Ludington in late August (Crowe 1979a). Peak collections near the rock jetties of the Ludington Pumped Storage Plant (43°54', 86°27') are made from mid-September through October during spawning runs (Brazo, pers. comm. 1979; Brazo and Liston 1977). Natural reproduction occurs in most of the streams in the vicinity, especially in the Pere Marquette River (43°56', 86°26') and the Lincoln River (43°59', 86°28') (Brazo, pers. comm. 1979; FWS 1979d). Most of the streams in Mason County have good concentrations of naturally spawned YOY (Brazo, pers. comm. 1979). Runs have been reported in the Pere Marquette River and its tributaries, including Sanborn Creek, Baldwin Creek, and Big South Branch (MDNR 1970).

Pentwater (43°47', 86°26'). In 1979, coho salmon schooled off Pentwater in late August (Crowe 1979a), and runs may enter the Pentwater River (43°46', 86°24') (Brazo, pers. comm. 1979).

MM-7

Stony Creek (43°34', 86°30'). Runs occur (Borgeson 1967).

Muskegon (43°13', 86°17'). Coho salmon enter and spawn successfully in the Muskegon River (43°15', 86°15') in October (Consumers Power 1976f; Crowe 1979a; FWS 1979d; MDNR 1970). Extensive spawning runs proceed up the river and enter Bigelow Creek, Newaygo County; choice spawning areas in the creek are used repeatedly throughout the spawning season, which lasts at least 90 days (Merna 1979).

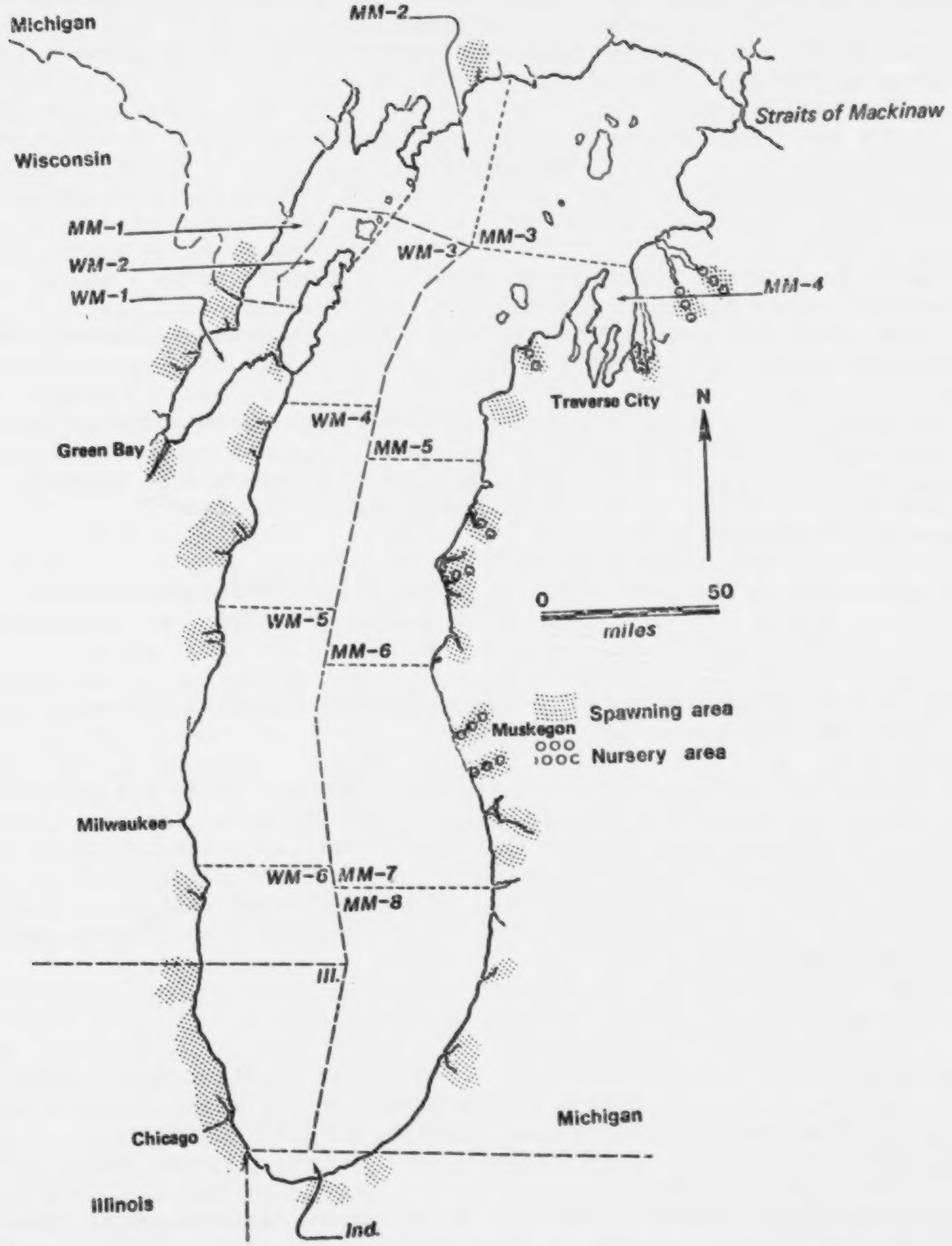
Port Sheldon (42°54', 86°13'). Adults migrate into the discharge canal of the Campbell Power Plant (42°55', 86°12') in October and November. Smolts or yearlings were collected with beach seines approximately 1 mi N and S of the Pigeon River (42°54', 86°12') and at the former discharge canal of the plant; most of these were probably stocked fish (Heufelder, pers. comm. 1979).

MM-8

St. Joseph River (42°07', 86°29'). A spawning run occurs (Jude et al. 1975; Crowe 1979a).

Bridgman (41°56', 86°35'). In 1973, many small coho salmon were seined in the beach zone near the Cook Power Plant (41°59', 86°34') in June (Jude et al. 1975). Stocked fingerlings are present in the beach zone (Jude et al. 1979b; Jude, pers. comm. 1979).

CHINOOK SALMON


Michigan
MM-2
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
MM-3
WM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Chinook salmon were first introduced into Lake Michigan in 1873, but self-sustaining populations were not established (Parsons 1973). Annual plantings of chinook salmon in Lake Michigan since 1967 (Daly et al. 1975; GLFC 1973a,b, 1975, 1976, 1978; Parsons 1973) have produced fall spawning runs in a number of tributaries, and self-sustaining populations are established in some areas (Carl 1977, 1978, 1979). The first reported spawning runs of chinook salmon in the Great Lakes occurred in the Muskegon (43°15', 86°15') and Little Manistee (44°13', 86°16') rivers in 1970 (Parsons 1973).

Wisconsin

WM-1

Almost every major tributary of Green Bay (45°05', 87°25') has a spawning run during September and October. Redd building and egg deposition occur, but reproduction is usually not successful (Belonger and Kernen, pers. comm. 1979).

Menominee River (45°06', 87°35'). A run occurs (Belonger and Kernen, pers. comm. 1979). Chinook salmon enter the river, which forms the boundary between Wisconsin and Michigan, in late October; some of these fish were tagged earlier at the Point Beach Power Plant (44°17', 87°32') (Spigarelli, unpubl. data).

Little River (45°03', 87°38'), Peshtigo River (44°58', 87°39'), Oconto River (44°54', 87°50'), and Pensaukee River (44°49', 87°54'). Runs occur from stocked returns (Belonger and Kernen, pers. comm. 1979).

Fox River (44°32', 88°00'). A run occurs (Belonger and Kernen, pers. comm. 1979; FWS 1979d).

Sturgeon Bay (44°53', 87°24'). Young-of-the-year (YOY) are stocked in the bay and frequent the entire Lake Michigan shoreline (Kernen, pers. comm. 1979). Tagging studies show that adults move into the bay in late October and November from the Point Beach area (44°17', 87°32') (Spigarelli, unpubl. data). Runs enter Strawberry Creek (44°49', 87°22'), and 2-3 million eggs are collected annually from these fish (Kernen, pers. comm. 1979; WDNR 1974b).

WM-4

Ahnapee River (44°36', 87°26'). A run occurs (Kernen, pers. comm. 1979). Tagging studies show that adults move into the river in September and October from the Point Beach area (44°17', 87°32') (Spigarelli, unpubl. data).

Kewaunee River (44°28', 87°30'). A run occurs (Kernen, pers. comm. 1979). During 1972-73, catches in Kewaunee Harbor (44°28', 87°30') peaked in September, prior to the major fall spawning run (Spigarelli and Thommes 1976). Ripe adults are collected in the vicinity of the Kewaunee Power

Plant (44°21', 87°32') during October when they move inshore; they congregate near the mouths of rivers or move into the rivers in the area. The substrate in the area is hard clay and cobble-size rock with a few boulders (LaJeone, pers. comm. 1979). Many chinook salmon tagged at the Point Beach Power Plant (44°17', 87°32') move into the Kewaunee River in October and November (Spigarelli, unpubl. data).

Point Beach Power Plant (44°17', 87°32'). In 1976, female chinook salmon were collected here from August through October (Wis. Elec. Power and Wis.-Mich. Power, undated c). During 1972-73, catches peaked in September, prior to the major spawning runs (Spigarelli and Thommes 1976).

East Twin River (44°09', 87°34'). A run occurs (Hanson, pers. comm. 1979). Fish move into the river in late October and early November from the area of the Point Beach Power Plant (44°17', 87°32') (Spigarelli, unpubl. data).

West Twin River (44°09', 87°34'). A run occurs; adults enter the river by mid-September (Hanson, pers. comm. 1979). During 1972 and 1973, catches peaked in September in Two Rivers Harbor (44°09', 87°34'), prior to the major spawning run (Spigarelli and Thommes 1976). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in the river in late October (Spigarelli, unpubl. data).

Little Manitowoc River (44°06', 87°39'). A run occurs (Hanson, pers. comm. 1979). Ripe fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in the river in October and November (Spigarelli, unpubl. data).

Manitowoc River (44°05', 87°39'). A run occurs; adults move into the river by September (Hanson, pers comm. 1979a). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in the river in mid- to late October (Spigarelli, unpubl. data).

WM-5

Haven (43°51', 87°44'). Ripe fish were collected in the area in October as they were moving inshore to rivers in the area (LaJeone, pers. comm. 1979).

Sheboygan River (43°45', 87°42'). A chinook salmon tagged at the Point Beach Power Plant (44°17', 87°32') moved into the river in late October (Spigarelli, unpubl. data).

WM-6

Root River (42°44', 87°47'). A chinook salmon tagged at the Point Beach Power Plant (44°17', 87°32') moved into the river in mid-October (Spigarelli, unpubl. data).

Illinois

Spawning runs occur in harbors all along the Illinois shoreline (Muench, pers. comm. 1979).

Kellogg Creek (42°28', 87°48'). A spawning run occurs from mid-September to the third week in October; eggs have been collected here (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In this area, a few ripe-running fish were collected over a substrate of fine sand with a few rocks (LaJeone, pers. comm. 1979), but no spawning is believed to occur in the area (Commonw. Edison 1976).

Indiana

Burns Waterway (41°38', 87°10') and Trail Creek (41°44', 86°54'). Chinook salmon move into the streams from early September through the third or fourth week of October (Koch, pers. comm. 1979; Morgan 1978). Chinook salmon enter Burns Ditch (Waterway) enroute to spawning grounds in the Little Calumet River (41°37', 87°10') (USAEC 1972f).

Michigan

MM-2

Manistique River (45°57', 86°15'). Some natural reproduction occurs (North Woods Call 1980a).

MM-3

Boyne River (45°13', 85°01'). Large spawning runs enter this river (GLFC 1972), and in 1978, naturally produced YOY were observed here (Galbraith 1978).

Jordan River (45°09', 85°08'). Runs enter this river and its tributaries (North Woods Call 1979n), and naturally produced YOY were found in Landslide Creek in May 1978 (Carl 1978).

MM-4

Elk River (44°54', 85°25'). A chinook salmon tagged on October 12 at the Point Beach Power Plant (44°17', 87°32') in Wisconsin was recaptured only 3 days later at the dam at Elk Rapids (Spigarelli, unpubl. data).

MM-5

Crystal River (44°55', 85°58'). Naturally produced YOY were found in this river in early June (Carl 1978).

Platte River (44°44', 86°09'). In 1972, runs entered this river in the fall (Taube 1974a). In 1979, chinook salmon schooled in Platte Bay (44°45', 86°07') during August (Crowe 1979a).

MM-6

Big (44°15', 86°18') and Little (44°13', 86°16') Manistee Rivers. Chinook salmon return to the Big and Little Manistee Rivers to spawn (Carl 1977, 1978, 1979; MDNR 1970; Merna 1979; Tody 1970). In the Little Manistee River, the first major spawning run occurred in 1970; redds were common, and large numbers of eggs were deposited (Parsons 1973). Between 1969 and 1974, spawning runs started as early as October 6 and ended as late as November 4. The duration of the run varied from 6 days to more than 3 weeks and the run usually peaked in mid-October (Parsons 1975). Chinook salmon school off the common mouth of these rivers and enter these rivers in August. Extensive spawning runs proceed up the Big Manistee River and into Pine Creek, a tributary to the Big Manistee River; choice spawning areas in Pine Creek are used repeatedly throughout the spawning period, which lasts at least 90 days (Merna 1979). Natural reproduction is widespread in the river, and large numbers of YOY are produced. In 1977-79, YOY were found in Pine Creek from early May to early June (Carl 1977, 1978, 1979).

Big Sable River (44°02', 86°30'). Heavy runs enter the river, but no natural reproduction occurs (Brazo, pers. comm. 1979; Carl 1979).

Pere Marquette River (43°56', 86°26'). In 1979, chinook salmon schooled off the mouth of the river in August (Crowe 1979a). Heavy spawning runs enter the river, and some natural reproduction results (Carl 1977, 1978, 1979; FWS 1979d; North Woods Call 1979n). Runs start on approximately the first of September and peak in October (Brazo, pers. comm. 1979). In 1977-79, YOY were found from early May to early June in the Baldwin River, a tributary to the Pere Marquette River (Carl 1977, 1978, 1979).

Ludington Pumped Storage Plant (43°54', 86°27'). Ripe chinook salmon are collected in the fall; these fish are probably migrating to area streams. Ripe adults are also attracted to the intake and discharge area of the plant (Brazo, pers. comm. 1979; Brazo and Liston 1977). Spawning runs in the area begin on about the first of September, and peak during October. By mid-June, large numbers of YOY are present in the immediate area of the plant; it is not known if these fish are naturally produced or planted (Brazo, pers. comm. 1979).

Pentwater River (43°46', 86°24'). Spawning runs are suspected (Brazo, pers. comm. 1979). In 1979, chinook salmon schooled at the mouth of the river in August (Crowe 1979a).

MM-7

White River (43°25', 86°21'). Runs presently occur in the river and its tributaries and peak around mid-October. Natural reproduction occurs throughout the watershed, and many YOY are produced (Burns 1979; Carl 1979).

Muskegon River (43°15', 86°15'). Stocked fish return to the river to spawn; natural reproduction is successful in this river (Carl 1977, 1978, 1979; Consumers Power 1976f; FWS 1979d; Merna 1979; Rybicki 1973; Tody 1970). The first major spawning run occurred in 1970; redds were common and large numbers of eggs were deposited (Parsons 1973). In 1979, chinook salmon schooled at the mouth of the river and were present in the river in August (Crowe 1979a). Extensive spawning runs proceed upstream as far as Bigelow Creek, Newaygo County, where choice spawning areas are used repeatedly throughout the spawning season, which lasts more than 90 days (Merna 1979). Natural reproduction is widespread in the Muskegon River, and large numbers of YOY are produced. In 1977-79, YOY were found in Bigelow Creek from early May to early June (Carl 1977, 1978, 1979).

Grand River (43°03', 86°15'). In 1979, chinook salmon entered the Grand River in August (Crowe 1979a).

Port Sheldon (42°54', 86°13'). Chinook salmon enter the Pigeon River (42°54', 86°12') in the fall to spawn. Many fish in spawning condition were observed in the discharge canal of the Campbell Power Plant (42°55', 86°12') in the fall (Jude et al. 1978, 1979a). Ripe adults enter the discharge and intake areas during October and November. Fingerlings, most of hatchery origin, are collected in beach seines in the areas approximately 1 mi N and S of the plant discharge (Jude 1978; Jude and Heufelder, pers. comm. 1979; Jude et al. 1978).

MM-8

Black River (42°24', 86°17'). During 1979, chinook salmon entered the Black River in August (Crowe 1979a).

Paw Paw River (42°07', 86°28'). A chinook salmon tagged at the Point Beach Power Plant (44°17', 87°32') was captured in the river in mid-September (Spigarelli, unpubl. data).

St. Joseph River (42°07', 86°29'). Most of the chinook salmon in the southeast Michigan area probably enter this river during the spawning season (Indiana-Mich. Power 1975; Jude et al. 1975). A fish tagged in late September at the Point Beach Power Plant (44°17', 87°32') was recaptured at the Berrien Springs Dam (41°55', 86°20') in late October (Spigarelli, unpubl. data). In 1979, chinook salmon schooled off the river mouth and entered the river in August (Crowe 1979a). There is an influx of chinook salmon every fall at the Cook Power Plant (41°59', 86°34') south of the St. Joseph River; these fish are undoubtedly migrating to the St. Joseph River to spawn (Jude 1977). Stocked fingerlings are present in the beach zone waters near the plant (Jude, pers. comm. 1979).

ROUND WHITEFISH

Round whitefish usually spawn in November and December over honeycombed rock and gravel in water 12-36 ft deep (Koelz 1929). Ripe round whitefish are collected from mid-October through November, at the same time that ripe lake whitefish are collected (Frederick, pers. comm. 1979).

Wisconsin

WM-3

Running-ripe and spent fish were collected on the reefs along the lake side of the Door Peninsula (45°05', 87°10') from mid-October through November (Copes, pers. comm. 1979; Frederick, pers. comm. 1979).

Rowley Bay (45°13', 87°01'). Running-ripe adults were collected over rock and patches of sand. Young-of-the-year (YOY) round whitefish and YOY lake whitefish were captured together here (Frederick, pers. comm. 1979).

North Bay (45°09', 87°04'). This bay is an historical spawning ground for round whitefish (Binkowski, pers. comm. 1979). Running-ripe round whitefish were collected in the bay over gravel and honeycombed rock from mid-October through November (Binkowski, pers. comm. 1979; Frederick, pers. comm. 1979). Young-of-the-year round whitefish and YOY lake whitefish were captured together here (Frederick, pers. comm. 1979).

Moonlight Bay (45°05', 87°05') and Baileys Harbor (45°03', 87°07'). Running-ripe adults were collected over rock and patches of sand. Young-of-the-year round whitefish and YOY lake whitefish were captured together here (Frederick, pers. comm. 1979).

Sturgeon Bay Ship Canal (44°48', 87°19'). In 1951, over 200 recently spent round whitefish were collected just north of the Ship Canal in 24 ft of water in mid-December (Mraz 1964a).

WM-4

Kewaunee Power Plant (44°21', 87°32') In the mid-1970s, ripe adults were collected in this area within the 15-30 ft depth contours in November. The substrate in these areas is hard clay with cobble-size rock; the substrate also includes a few boulders near Haven (LaJeone, pers. comm. 1979).

WM-5

Haven (43°51', 87°44'). In the mid-1970s, ripe adults were collected in this area within the 15-30 ft depth contours in November. The substrate in these areas is hard clay with cobble-size rock; the substrate also includes a few boulders near Haven (LaJeone, pers. comm. 1979).

Michigan

MM-1

Middle Bluff (45°44', 86°39'). Since 1915, spawning has occurred here over sand and gravel (Organ et al. 1978).

MM-2

Wiggins Point Shoal (45°51', 86°18')--Manistique (45°57', 86°15'). Since the 1920s, spawning has occurred along this shoreline over sand, gravel, and rock at a depth of about 12 ft. Since 1940, spawning has occurred at Wiggins Point Shoal over rock and gravel (Organ et al. 1978).

MM-3

Scott Point (45°58', 85°42')--Rock River (46°05', 85°32'). Since 1950, spawning has occurred here over rock, sand, and gravel at depths of 6-24 ft (Organ et al. 1978).

Rock River (46°05', 85°32')--Biddle Point (46°05', 85°23'). From 1967 to 1969, spawning occurred here over rock at depths of 6-30 ft (Organ et al. 1978).

Potter Reef (46°00', 85°32'). From 1967 to 1969, spawning occurred here over rock (Organ et al. 1978).

Biddle Point (46°05', 85°23')--Davenport Creek (46°04', 85°16'). Spawning occurred (no dates given) east of the creek on a small area (46°03', 85°15') of sand and gravel in 6-8 ft of water. Since 1950, spawning has occurred along the entire shoreline from the mouth of the creek west to Biddle Point, over rock and gravel at depths of about 6-30 ft (Organ et al. 1978).

Brevort (46°01', 85°02'). From the 1940s to 1976, spawning occurred on rock areas east and west of Brevort (Organ et al. 1978).

Manitou Paymen Shoal (45°58', 85°04'). From 1965 to 1976, spawning occurred here over rock (Organ et al. 1978).

St. Helena Island (45°52', 84°52') and Shoal (45°52', 84°55'). Spawning occurred (no dates given) along the south side of the island and around the shoal over rock at depths of 40-50 ft (Organ et al. 1978).

Fox Islands (45°27', 85°50'). From 1954 to 1971, spawning occurred on the northeast shore of South Fox Island (45°25', 85°51'), on the entire shoal area off the southern tip of the island, and off the southwest end of North Fox Island (45°29', 85°47') (Organ et al. 1978).

MM-4

Grand Traverse Bay (45°05', 85°30'). Spawning has occurred over rock and gravel in the outer part of Bowers Harbor (44°53', 85°33')--Marion Island (44°52', 85°35') (Organ et al. 1978). Round whitefish are taken in Bowers Harbor, at Northport Point (45°08', 85°33'), and at Raft's Camp (location unknown) as they move inshore during October and November to spawn (Price and Kelly 1976).

MM-5

Leelanau Peninsula (45°00', 85°40'). In 1954 to 1971, spawning occurred along shore at 45°07', 85°41' (Organ et al. 1978).

Manitou Islands (45°04', 86°03'). From 1954 to 1971, spawning occurred along the entire east side (45°02', 86°07'--45°00', 86°06') of South Manitou Island (45°01', 86°08'), along the southwest shore of North Manitou Island (45°07', 86°01') from Donner Point (45°03', 86°00') north to 45°05', 86°03', and over sand along the north and east shores of North Manitou Island south to Dimmicks Point (45°04', 86°58'). From 1916 to 1971, spawning occurred on the North Manitou Shoals (45°02', 85°58') over sand and rock (Organ et al. 1978).

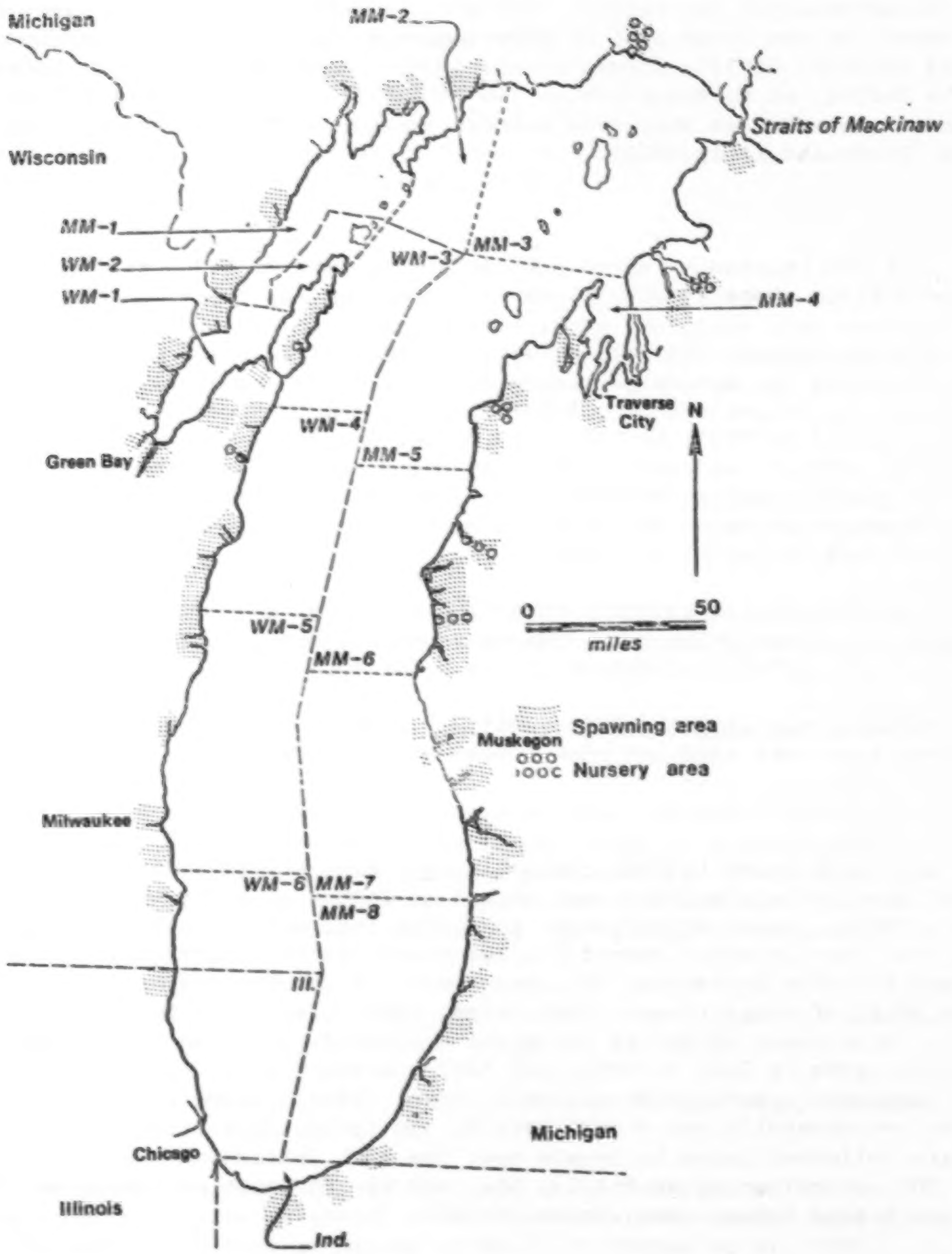
Carp River Point (45°01', 85°47'). From 1954 to 1971, spawning occurred along the point over unknown substrate and on the rocky shoal area (45°02', 85°49') northwest of the point (Organ et al. 1978).

Pyramid Point Shoal (44°59', 85°55'). From 1954 to 1971, spawning occurred here over sand and rock (Organ et al. 1978).

MM-6

Big Sable Point (44°03', 86°31')--Ludington (43°57', 86°28'). Round whitefish spawn along shore over gravel at depths of about 15-18 ft (Organ et al. 1978). Round whitefish begin moving into waters less than 30 ft deep near the Ludington Pumped Storage Plant (43°54', 86°27') in large numbers in early September; abundance peaks in October and November in about 28 ft of water (Brazo, pers. comm. 1979; Liston and Tack 1973, 1975). Ripe round whitefish are first collected in the area in November; spawning peaks in late November and early December after lake whitefish have completed spawning (Brazo, pers. comm. 1979; Consumers Power 1972a). Larvae are generally not caught here in the spring, but large numbers of YOY are collected later in trawls near the rock jetties of the plant. More YOY are collected at the 5-, 10-, and 15- ft depth contours than in the beach zone (Brazo, pers. comm. 1979).

RAINBOW TROUT


Michigan
MM-2
Wisconsin
Straits of Mackinaw
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Chicago
Michigan
Illinois
Ind.

Rainbow trout, or "steelheads," were first introduced into the Lake Michigan drainage in 1880 when fry were planted in the Boyne, Paw Paw, and Kalamazoo rivers (Smiley 1881, as cited in MacCrimmon and Gots 1972). The first recorded capture of rainbow trout in Lake Michigan waters were young recovered from the Pere Marquette River, Michigan, in 1886 from plantings made in the previous year. The first natural reproduction was recorded in the Muskegon River, where fish planted in 1886 spawned the following spring in Cheney Creek, a tributary of the Muskegon River (Smedley 1938). By 1920, rainbow trout were present throughout most of Lake Michigan. Rainbow trout stocks in Lake Michigan diminished in the 1950s, possibly as a result of the invasion of the sea lamprey in 1936 and the beginning abundance of alewife in 1949 (MacCrimmon and Gots 1972). Beginning in 1955, rainbow trout were planted in many Lake Michigan tributaries during various years (GLFC 1978, in press; Hansen and Stauffer 1967, 1971; Morgan 1978a).

Rainbow trout are generally distributed and are locally abundant throughout the lake, but spawning runs are limited essentially to Michigan and Wisconsin tributaries (MacCrimmon and Gots 1972). Steelheads move into tributaries and seek suitable gravel areas for spawning (Shetter 1937; Smith and Van Oosten 1939). Spring and fall runs have become established; the fall runs are minor compared to spring runs (Becker 1976). Fall run rainbow trout may overwinter in the streams and spawn in the spring (Koch, pers. comm. 1979; Taube 1974a). There is evidence that fall spawners will drop eggs in the lake if stream conditions are not suitable (Daly 1968b, as cited in Becker 1976). Spawning occurs as early as November (Jude et al. 1978) or as late as May (Brazo, pers. comm. 1979).

Wisconsin

Most Wisconsin tributaries to Lake Michigan proper and to Green Bay (45°05', 87°25') have spring and fall runs of steelheads; adults are present in these streams from January through April (Belonger and Kernen, pers. comm. 1979; Copes, pers. comm. 1979). In Wisconsin about half of the steelheads migrate and spawn in the spring, the other half in the fall (Romberg and Spigarelli 1973). Redd building and egg deposition occur, but little or no successful spawning, hatching, or recruitment occurs (Belonger and Kernen, pers. comm. 1979).

WM-1

Menominee River (45°06', 87°35') (Belonger and Kernen, pers. comm. 1979).

Little River (45°03', 87°38') (Belonger and Kernen, pers. comm. 1979). In 1972 to 1974, fish tagged at the Point Beach Power Plant (44°17', 87°32') were recovered in the river in late November and early May (Spigarelli, unpubl. data).

Peshtigo River (44°58', 87°39') (Belonger and Kernen, pers. comm. 1979). A fish tagged on October 2 at the Point Beach Power Plant (44°17', 87°32') was recovered 9 days later below the dam in the river (Spigarelli, unpubl. data). The removal of dams on the Peshtigo River would increase access to prime spawning grounds (GLFC 1979b).

Oconto River (44°54', 87°50') (Belonger and Kernen, pers. comm. 1979; Carlson et al. 1977). Ripe-running males and females have been collected in the river (Imhof, pers. comm. 1979). The removal of dams on the Oconto River would increase access to prime spawning grounds (GLFC 1979b).

Pensaukee River (44°49', 87°54') (Belonger and Kernen, pers. comm. 1979; Imhof, pers. comm. 1979). A few ripe-running males and females have been collected here (Imhof, pers. comm. 1979).

Little Suamico River (44°42', 87°59'). A few ripe-running males and females have been collected here (Imhof, pers. comm. 1979).

Duck Creek (44°34', 88°02'). A fish tagged at the Point Beach Power Plant (44°17', 87°32') was recaptured here in early January (Spigarelli, unpubl. data).

Fox River (44°32', 88°00') (Belonger and Kernen, pers. comm. 1979). A large egg tentatively identified as a rainbow trout egg was entrained from the Fox River at the Pulliam Power Plant (44°32', 88°00') (NALCO, undated a).

Red River (44°40', 87°45'). Ripe-running males and females were collected here; these were planted fish (Imhof, pers. comm. 1979).

Strawberry Creek (44°49', 87°22'). Eggs were collected here (Kernen, pers. comm. 1979).

WM-3

Reiboldt Creek (45°06', 87°05'). Significant natural reproduction occurs here (MacCrimmon and Gots 1972).

Baileys Harbor (45°03', 87°07'). Several fish tagged at the Point Beach Power Plant (44°17', 87°32') were recovered here in October and November (Spigarelli, unpubl. data).

Hibbard Creek (44°59', 87°10'). Significant natural reproduction occurs here (MacCrimmon and Gots 1972).

Whitefish Bay Creek (44°55', 87°13'). Significant natural reproduction occurs here (MacCrimmon and Gots 1972). Successful reproduction occurred here in 1964-1966; fingerlings were collected from the creek (Daly 1968a).

Stony Creek (44°40', 87°23'). Ripe-running males and females were collected here (Imhof, pers. comm. 1979). Fish tagged at the Point Beach Power Plant (44°17', 87°32') in September and October were recovered here in October and the beginning of December (Spigarelli, unpubl. data). Successful reproduction has occurred here; yearlings and fingerlings have been collected from the creek (Daly 1968a).

Ahnapee River (44°36', 87°26') (Kernen, pers. comm. 1979). Ripe-running adults were collected here; these fish were stocked as smolts in Silver Creek, a tributary of the Ahnapee River (Imhof, pers. comm. 1979). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were found in the river in October, November, and April and in Silver Creek in October (Spigarelli, unpubl. data).

Three Mile Creek (44°34', 87°27') and Mashek Creek (44°30', 87°29'). Ripe-running males and females were collected here (Imhof, pers. comm. 1979).

Kewaunee River (44°28', 87°30') (Kernen, pers. comm. 1979; Imhof, pers. comm. 1979). Ripe-running males and females were collected here (Imhof, pers. comm. 1979). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in the river (Spigarelli, unpubl. data). Significant natural reproduction occurs in Little Scarboro Creek, a tributary of the Kewaunee River (MacCrimmon and Gots 1972). Yearlings were collected here (Daly 1968a). In 1971 and 1972, young-of-the-year (YOY) averaging 2.7 in. long were collected in Little Scarboro Creek during September. In 1972, yearlings migrated out of the creek between April and August (Avery 1974).

Kewaunee Power Plant (44°21', 87°32'). An onshore migration occurs during the spawning season from September to December. The substrate in the area is hard clay and cobble-size rock with a few boulders (LaJeone, pers comm. 1979).

Point Beach Power Plant (44°17', 87°32'). Rainbow trout are most abundant in the area during the fall and spring spawning migrations (Romberg and Thommes 1974). From November 1975 through March 1976, ripe females were collected here (Wis. Elec. Power and Wis.-Mich. Power, undated c).

Molash Creek (44°11', 87°31'). An extensive spring run enters the creek (Weber, Desparte, and Threinen 1968).

East and West Twin Rivers (44°09', 87°34'). Spawning runs enter these rivers (Hanson, pers. comm. 1979; Weber, Desparte, and Threinen 1968). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in the West Twin River in December and in the East Twin River in December and April (Spigarelli, unpubl. data).

Little Manitowoc River (44°06', 87°39') (Hanson, pers. comm. 1979; Weber, Desparte, and Threinen 1968). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured here in November (Spigarelli, unpubl. data).

Manitowoc River (44°05', 87°39') (Hanson, pers. comm. 1979; Weber, Desparte, and Threinen 1968). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured here in November and in March of the following year (Spigarelli, unpubl. data).

Silver Creek (44°04', 87°39') (Weber, Desparte, and Threinen 1968). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recovered here in October and November (Spigarelli, unpubl. data).

Pine Creek (43°59', 87°42'). One fish tagged at the Point Beach Power Plant (44°17', 87°32') was recovered here in late April (Spigarelli, unpubl. data).

Point Creek (43°58', 87°42'). A spring run occurs here (Weber, Desparte, and Threinen 1968).

Fischer Creek (43°56', 87°43') (Avery 1974; Belonger and Kernen, pers. comm. 1979; Weber, Desparte, and Threinen 1968). In the past, minor natural reproduction occurred here (Belonger and Kernen, pers. comm. 1979). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured here in early November (Spigarelli, unpubl. data).

Centerville Creek (43°55', 87°43'). A spawning run occurs here (Weber, Desparte, and Threinen 1968).

WM-5

Sevenmile Creek (43°51', 87°44'). In 1974, adults in spawning condition were collected near the creek in March and in the creek in May (Ind. Bio-Test 1977; LaJeone, pers. comm. 1979).

Pigeon River (43°47', 87°43') (Weber, Desparte, and Threinen 1968; Weber, Poff, and Threinen 1968). Two fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured here in mid-March (Spigarelli, unpubl. data).

Sheboygan River (43°45', 87°42') (Weber, Poff, and Threinen 1968). A fish tagged at the Point Beach Power Plant (44°17', 87°32') was recovered in the river in late October (Spigarelli, unpubl. data).

Black River (43°42', 87°42') (Weber, Poff, and Threinen 1968). In 1974, six ripe adults were collected in the discharge of the Edgewater Generating Station (43°43', 87°42'), near the river, in early March. In 1975, three ripe or mature females were impinged in late March and early April. In 1977, ripe and spent steelheads were collected at the pier in April, May, October, and December (Swanson Environ. 1976, 1979).

Port Washington (43°23', 87°52'). Fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured here in late October, November, and February. In mid-February, one ripe adult was captured in Sauk Creek (43°23', 87°52') (Spigarelli, unpubl. data). In 1975, ripe adults were impinged at the Port Washington Power Plant (43°23', 87°52') (Wis. Elec. Power 1976e).

Milwaukee River (43°02', 87°54'). Spawners run up the river in April to the North Avenue Dam (Norden, pers. comm. 1980).

Oak Creek (42°54', 87°51'). Ripe females were collected here at the end of April and May (Norden, pers. comm. 1979).

WM-6

Root River (42°44', 87°47'). A fish tagged at the Point Beach Power Plant (44°17', 87°32') in June was recaptured at Racine (42°44', 87°47') in early November; another tagged in September was recaptured in the river in late November (Spigarelli, unpubl. data).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Ripe-running adults are occasionally collected in this area over a substrate of fine sand and scattered rocks during the spring and fall (Cochran, undated; LaJeone, pers. comm. 1979). A spawning run enters Kellogg Creek (42°28', 87°48'); in 1979, fish were observed making redds in the mouth of the creek in April (Muench, pers. comm. 1979). In 1975, one egg was collected at the Zion Generating Station (42°27', 87°48') in June (Cima et al. 1976).

Indiana

Spawning runs into tributaries usually begin in August. Adults remain in the tributaries over winter, spawn during March and April, and then return to the lake. Very little successful natural reproduction occurs (Koch, pers. comm. 1979).

Burns Waterway (41°38', 87°10'). Spawning runs enter Burns Waterway and the Little Calumet River (41°37', 87°10') (Koch, pers. comm. 1979).

Bailly Generating Station (41°39', 87°07'). The abundance of mature steelheads in the fall suggests that spawning may occur here in the lake (Tex. Instrum. 1975b, 1977b).

Trail Creek (41°44', 86°54'). Spawning runs enter the creek (Koch, pers. comm. 1979; Morgan 1978c) until early December or ice-up; the run begins again in the spring after ice breakup (Morgan 1978c).

Michigan

MM-1

Turtle Creek (45°09', 87°36'). A fish tagged at the Point Beach Power Plant (44°17', 87°32') was caught on November 1 in the creek (Spigarelli, unpubl. data).

Beattie Creek (45°14', 87°31'). A fish tagged at the Point Beach Power Plant (44°17', 87°32') was recovered (date unknown) in spent condition in the creek (Spigarelli, unpubl. data).

Cedar River (45°24', 87°21'). Spawning runs enter this river from mid-April to early June (Ann Arbor News 1979a).

Whitefish River (45°55', 86°57'). A small run occurs from natural reproduction and stocking (FWS 1979d; MacCrimmon and Gots 1972).

Fishdam River (45°54', 86°35') and Sturgeon River (45°50', 86°40'). A small run occurs in these rivers (MacCrimmon and Gots 1972).

MM-2

Thompson Creek (45°54', 86°19'). Spawning runs enter Thompson Creek from mid-April to early June (Ann Arbor News 1979a; MacCrimmon and Gots 1972). In 1979, rainbow trout appeared at the mouth of this creek in August (Crowe 1979a). Steelheads tagged at the Point Beach Power Plant (44°17', 87°32') were caught in Thompson Creek; two were taken on September 1 and a third fish was taken at the end of October (Spigarelli, unpubl. data).

Manistique River (45°57', 86°15'). A fish tagged at the Point Beach Power Plant (44°17', 87°32') was recovered in the Manistique River in late October (Spigarelli, unpubl. data).

MM-3

Black River (46°06', 85°21'). Since the early 1950s, large runs have occurred here (Robertson and Cheney 1953; Stauffer 1972; Westerman 1952b, 1954, 1957a) from mid-April to early June (Ann Arbor News 1979a). Downstream migration of juveniles, in their second or third year of life, begins in late April, when the water temperature reaches about 45-50°F, and continues to late July; peak migration occurs from late May through June at temperatures of about 48-63°F (Stauffer 1972a).

Boyne River (45°13', 85°01'). Large runs occur in April (Ann Arbor News 1979a; GLFC 1973), and naturally produced young have been collected (Galbraith 1978).

Jordan River (45°09', 85°08'). A run occurs in April (Ann Arbor News 1979a).

MM-4

Boardman River (44°46', 85°37'). A run occurs in April (Ann Arbor News 1979a; MacCrimmon and Gots 1972; UPI 1979).

MM-5

Leland (Carp) River (45°01', 85°46'). A run occurs in April (UPI 1979).

Otter Creek (44°46', 86°04'). A minor spring run occurs (Edsall, pers. comm. 1979).

Platte River (44°44', 86°09'). Since the 1920s, spawning runs have occurred in April and May (Ann Arbor News 1979a; Carbine and Shetter 1945; Greeley 1933; Taube 1969, 1974a, 1975; UPI 1979; Westerman 1942). Some adults also enter the river in the fall, mainly in October, and remain in the river throughout the winter (Carbine and Shetter 1945; Taube 1974a). In 1968-72, redds were observed during April (Taube 1971a,b, 1974b). In 1970-1972, YOY were collected from nursery areas in the stream during the fall (Taube 1971a,b, 1972, 1973). The migration of smolts to Lake Michigan usually begins in April and peaks during May and June (Taube 1974c, 1975). Steelheads are no longer planted here, and the river is managed for "wild" steelheads (North Woods Call 1980d).

Betsie River (44°37', 86°13'). Since the late 1920s, runs have been reported in April and May (Ann Arbor News 1979a; Shetter 1937; UPI 1979; Westerman 1950, 1952b, 1954, 1957a,b).

MM-6

Big (44°15', 86°18') and Little (44°13', 86°16') Manistee Rivers. These two streams empty into Lake Manistee which discharges into Lake Michigan. Since the late 1920s, spawning runs have entered both streams in April and May (Cook 1961, 1962; Greeley 1932, 1933; Hubbs 1930; MacCrimmon and Gots 1972; Rybicki 1973; Shetter 1937, 1938b; Taube 1974a; Tody 1969, 1970; Westerman 1930, 1950, 1952b, 1954, 1957a,b, 1959; Wicklund and Dean 1957). From 1929 to 1931, tagging of adult steelheads on the spawning grounds in the Big and Little Manistee Rivers during late April and early May indicated that steelheads generally return to the same river to spawn; however, some straying was observed (Shetter 1937, 1938b). Eggs and fry were found in the Little Manistee (Greeley 1932). In 1979, runs were expected to peak in April in both rivers (Ann Arbor News 1979a,b; UPI 1979). Steelhead do not appear to move into these rivers in large numbers during the fall (Wicklund and Dean 1957). A fish tagged at the Point Beach Power Plant (44°17', 87°32') in October was captured in late April in Bear Creek, a tributary of the Big Manistee River (Spigarelli, unpubl. data). The Little Manistee River is no longer planted and is managed for "wild" steelheads; this river reportedly has the best run of wild steelheads in the Great Lakes (North Woods Call 1979a, 1980d).

Big Sable River (44°02', 86°30'). A fish tagged at the Point Beach Power Plant (44°17', 87°32') in early October was recovered at the river mouth in early November (Spigarelli, unpubl. data).

Pere Marquette River (43°56', 86°26'). Spring and fall runs enter the river; the major run begins in late March and peaks in mid-April (Ann Arbor News 1979a,b; Baz 1979; FWS 1979d; Greeley 1933; UPI 1979). Steelheads are no longer planted, and the river is managed for "wild" steelheads (North Woods Call 1980d).

Ludington Pumped Storage Plant (43°54', 86°27'). Many ripe adults were collected as early as January near the plant (Brazo, pers. comm. 1979; Liston 1976). Most were taken near shore at depths of 10 ft or less; large numbers were taken around the rock jetties of the plant. Peak runs occur in March and early April (Brazo and Liston 1977). Ripe adults are collected in the storage reservoir which contains water pumped from Lake Michigan. A small unnamed stream about 300 ft long just south of the lower jetty, has a small spawning run in the fall (Brazo, pers. comm. 1979; Liston 1976); redds and YOY are observed, indicating that successful natural reproduction occurs in the stream. Ripe steelheads are collected as early as October 1, but the fall run peaks in November. Ripe adults are occasionally collected throughout the fall and early winter. Large numbers of ripe steelhead are taken in late March, when the ice breaks up. The spawning season extends into mid-May, and a few ripe adults are taken as late as June 1 (Brazo, pers. comm. 1979).

Pentwater River (43°47', 86°26'). Spring and fall runs occur (Brazo, pers. comm. 1979).

MM-7

White River (43°25', 86°21') (UPI 1979). Runs usually peak in late April (Ann Arbor News 1979a). From 1952 to 1962, spawning occurred in Lake Michigan on rock areas nearshore, about 2 mi N and 1 mi S of White Lake (43°23', 86°26') (Organ et al. 1978).

Muskegon River (43°15', 86°15') (Consumers Power 1976f; FWS 1979d; Greeley 1933; MacCrimmon and Gots 1972; Shetter 1937; UPI 1979; USDI 1966). Runs usually peak in late April (Ann Arbor News 1979a,b). An adult tagged at the Point Beach Power Plant (44°17', 87°32') in late September was recovered in late November at Croton Dam (Spigarelli, unpubl. data).

Grand River (43°03', 86°15'). Limited runs occur here (Ann Arbor News 1979a; MacCrimmon and Gots 1972; Nottingham 1979; UPI 1979). In 1979, runs were predicted to peak from mid-April to the first of May (Nottingham 1979).

Pigeon River (42°54', 86°12'). Ripe-running and spent adults were collected from late September to November along the Lake Michigan shore north and south of the river, when the water temperature was 50°F (Jude, pers. comm. 1979; Jude et al. 1978, 1979a). Spring-run steelheads were also collected in the area (Jude, pers. comm. 1979). A ripe-running male steelhead was collected in Pigeon Lake (42°54', 86°12') in November (Jude et al. 1978).

Kalamazoo River (42°40', 86°13'). Limited runs occur here (MacCrimmon and Gots 1972); the runs usually peak in late April (Ann Arbor News 1979a).

Black River (42°24', 86°17'). Limited runs occur here (MacCrimmon and Gots 1972); the runs usually peak here in late April (Ann Arbor News 1979a). A fish tagged at the Point Beach Power Plant (44°17', 87°32') in mid-October was recovered in the river in early December (Spigarelli, unpubl. data).

Palisades Power Plant (42°19', 86°19'). Many ripe and spent steelheads were collected and observed in the plant discharge through most of December 1972 and early January 1973 and again in October 1973 (Consumers Power 1973b, 1974, 1975).

St. Joseph River (42°07', 86°29') (Ann Arbor News 1979a,b; North Woods Call 1979d; UPI 1979). Limited runs occur here (MacCrimmon and Gots 1972); runs usually peak in late April (Ann Arbor News 1979a). In 1979, runs occurred from mid- to late April (Ann Arbor News 1979b; UPI 1979).

Bridgman (41°56', 86°35'). In 1973, ripe-running steelheads were taken near the Cook Power Plant (41°59', 86°34') in October and February (Jude et al. 1975). Spent fish were observed in the area in November, March, and May; gonad data suggest a spawning peak from November to January and another in March (Jude et al. 1979b).

Galien River (41°48', 86°45'). Spawning runs peak in late April (Ann Arbor News 1979a).

ATLANTIC SALMON

Atlantic salmon were first introduced into Lake Michigan in 1872; subsequent intermittent plantings occurred until 1932. No self-sustaining populations were established from these plantings (Parsons 1973; Wells and McLain 1973).

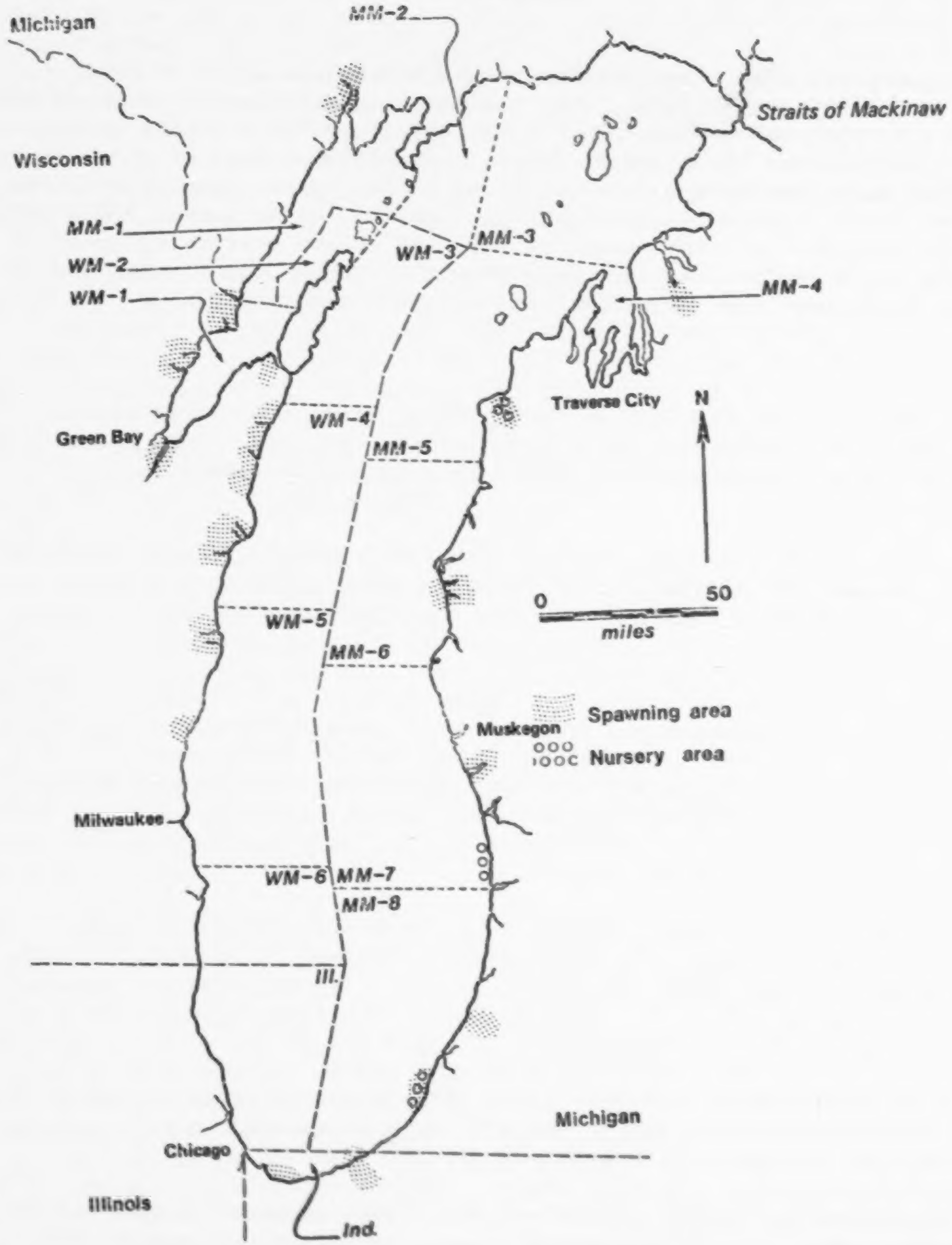
Michigan

Between 1972 and 1977, Atlantic salmon were planted in the Pere Marquette (43°56', 86°26'), Little Manistee (44°13', 86°16'), Platte (44°44', 86°09'), and Boyne (45°13', 85°01') rivers (Galbraith 1977, 1978; GLFC 1973b, 1975, 1976a, 1978, in press; Rybicki 1973). These plantings were largely unsuccessful (few returns to stocked tributaries) (Galbraith 1978), and no plantings have occurred in recent years.

MM-3

Boyne River (45°13', 85°01'). In 1974-77, a few fish returned to spawn in late October and the latter half of November, but in 1978 only one adult was observed (Galbraith 1976, 1977, 1978). Hatchery-reared brood stock planted in the Boyne River spawned and produced young that were observed in 1977 (Galbraith 1977).

BROWN TROUT



Michigan
MM-2
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Brown trout were planted in Lake Michigan as early as 1883. Those planted in Lake Michigan since the mid-1960s have produced fall spawning runs in a number of Lake Michigan tributaries (Wells and McLain 1973); self-sustaining populations are established in some areas.

Wisconsin

Brown trout were first planted in the Wisconsin waters of Lake Michigan in 1966 (Daly 1968b); they now spawn in tributaries of Green Bay (45°05', 87°25') and the Door Peninsula (45°05', 87°10') mainly in fall (Copes, pers. comm. 1979; Kernen, pers. comm. 1979). Most of the bays in this area have populations of brown trout (Copes, pers. comm. 1979). Fall runs are often limited by tributary flow (Kernen, pers. comm. 1980). When low flow prevents runs into streams, spawning occurs over rocky areas in the lake (Daly 1968b). Adults often drop their eggs around docks and harbors along the Door Peninsula (Kernen, pers. comm. 1980).

WM-1

Menominee River (45°06', 87°35'). Brown trout enter this river to spawn (Belonger and Kernen, pers. comm. 1979). In 1973, brown trout were collected at Marinette (45°05', 7°35') in late October (Spigarelli and Smith 1976).

Little (45°03', 87°38'), Peshtigo (44°58', 87°39'), Oconto (44°54', 87°50'), Pensaukee (44°49', 87°54') and Fox (44°32', 88°00') Rivers. Spawning runs enter these rivers in the fall (Belonger and Kernen, pers. comm. 1979).

Sturgeon Bay (44°53', 87°24'). Spawning runs enter Strawberry Creek (44°49', 87°22') (Belonger and Kernen, pers. comm. 1979). In 1972-74, fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in Sturgeon Bay and Big Creek (location unknown) off Sturgeon Bay in mid- and late October (Spigarelli, unpubl. data).

WM-3

Baileys Harbor (45°03', 87°07'). In 1972-74, brown trout were captured in Baileys Harbor in mid- and late October (Spigarelli, unpubl. data; Spigarelli and Smith 1976).

WM-4

Stony Creek (44°40', 87°23'). In 1972-74, brown trout tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in the creek in early October (Spigarelli, unpubl. data).

Ahnapee River (44°36', 87°26'). This river supports a spawning run of stocked brown trout (Kernen, pers. comm. 1979); fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in the river in late September and October (Spigarelli, unpubl. data).

Kewaunee River (44°28', 87°30'). Stocked brown trout have returned to the river to spawn (Kernen, pers. comm. 1979). In 1972-74, fish tagged at the Point Beach Power Plant (44°17', 87°32') entered the Kewaunee River in late September to mid-October. Fish taken in mid-September were not quite ripe; those taken in early October were ripe (Spigarelli, unpubl. data).

Kewaunee Power Plant (44°21', 87°32'). In 1975, ripe-running brown trout were collected in September and October at the intake to the plant in 20 ft of water, 1/2 mi N of the plant in 12 ft of water, and 2 mi S of the plant in 15 ft of water; the water temperature was 45-46°F at these locations. Spent adults were collected at these same sites in November when the water temperature was about 44°F (LaJeone 1976). Inshore spawning migrations occurred here from September to December (NALCO undated b). Ripe adults were collected in the vicinity of the plant over hard clay and cobble-size rocks (LaJeone, pers. comm. 1979).

Point Beach Power Plant (44°17', 87°32'). In 1975, brown trout were collected for fecundity counts in the vicinity of the Point Beach Power Plant in September and October (Wis. Elec. Power and Wis.-Mich. Elec. Power, undated c). Spawning brown trout are attracted to the plant discharge and accumulate in great numbers there seasonally (Reed 1972). In 1974, 48% of the salmonids tagged here during the fall were brown trout (Romberg and Thommes 1974). Fish captured during the second and third weeks of October were ripe to very ripe, and one collected on October 3 was spent (Spigarelli, unpubl. data).

Two Rivers (44°09', 87°34'). Stocked brown trout return to and enter the East and West Twin rivers (44°09', 87°34') in the fall (Hansen, pers. comm. 1979). In 1972-74, fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in late September and early October in Two Rivers Harbor and in the West Twin River (Spigarelli, unpubl. data).

Manitowoc (44°05', 87°39'). Stocked brown trout return to and enter the Manitowoc (44°05', 87°39') and Little Manitowoc (44°06', 87°39') rivers in the fall (Hansen, pers. comm. 1979). In 1972-74, fish tagged at the Point Beach Power Plant (44°17', 87°32') were recaptured in late September and early October in the Little Manitowoc River and also in Silver Creek (44°04', 87°39') (Spigarelli, unpubl. data).

WM-5

Sheboygan (43°45', 87°42'). The Pigeon River (43°47', 87°43') supports a run (Weber, Poff, and Threinen 1968). In 1975, adults were observed on redds in the Pigeon River in early October (LaJeone, pers. comm. 1979). Ripe-running adults have been collected near Haven (43°51', 87°44'), just north of the river, over a hard clay and cobble-sized rock substrate with a few boulders. Fish in spawning condition were collected along the shoreline in October 1974 and November 1973 (Ind. Bio-Test 1977; Wis. Elec. Power et al. 1979a). Most of these fish were collected at the 20- and 30-ft depth contour. The substrate was generally small rock cobble and boulders overlaying hard clay; areas of sand and gravel covered with silt occurred among the rocks (Ind. Bio-Test 1977). Brown trout tagged at the Point Beach Power Plant (44°17', 87°32') moved into the

Sheboygan area and the mouth of the Pigeon River in early to mid-October. One fish recaptured on November 8 was spent (Spigarelli, unpubl. data).

Black River (43°42', 87°42'). A spawning run enters the river (Weber, Poff, and Threinen 1968).

Port Washington (43°23', 87°52'). In 1975, most large adults impinged at the Port Washington Power Plant (43°23', 87°52') in early October were in breeding condition (Wis. Elec. Power 1976e).

Illinois

Waukegan (42°22', 87°50'). Brown trout are in spawning condition in the fall in the Waukegan area. The substrate in this area is fine sand with scattered rocks (LaJeone, pers. comm. 1979). In 1972, two running-ripe males were collected at the Waukegan Generating Station (42°23', 87°49') on October 25 and 26 (Cochran undated).

Indiana

Spawning may occur at several different locations along the Indiana shore (Koch, pers. comm. 1979).

Bailly Generating Station (41°39', 87°07'). In 1974 and 1975, sexually mature fish were observed here during the fall (Tex. Instrum. 1977b).

East Chicago (41°39', 87°26'). Stocked brown trout return to spawn at Joerse Park (41°39', 87°26') (Koch, pers. comm. 1979).

Michigan City (41°43', 86°54'). Spawning-run brown trout are collected in Trail Creek (41°44', 86°54') in August and September. Spawning was observed in the Michigan City Yacht Basin (41°43', 86°54') in 3-4 ft of water in September. Spawning was also observed in the Outer Basin on both sides of the mouth of Trail Creek (Koch, pers. comm. 1979). Brown trout in spawning condition were netted in early October at the Michigan City Generating Station (41°43', 86°54') (Morgan 1978b).

Michigan

MM-1

Whitefish River (45°55', 86°57') and Rapid River (45°55', 86°58'). Large spawning runs enter these rivers in September (North Woods Call 1980b).

Days River (45°54', 86°59'). A very small run enters the river, unless there are fall rains (North Woods Call 1980b).

MM-3

Jordan River (45°09', 85°08'). Brown trout spawn in tributaries of this river (North Woods Call 1979n).

MM-5

Platte River (44°44', 86°09'). Spawning runs enter the river. In 1968-71, spawning was observed on gravel bottom (Taube 1974b). In 1970, spawning was observed on November 8 (Stauffer 1971). Young fish move out into Lake Michigan at an early age and return in summer and fall (Taube 1974a).

MM-6

Ludington (43°57', 86°28). A spawning run enters the Pere Marquette River (43°56', 86°26') (FWS 1979d). Large numbers of ripe adults are taken at the Ludington Pumped Storage Plant (43°54', 86°27') beginning in late August; peak catches are from October through mid-November. Concentrations of adults occur around the rock jetties at the plant intake, and many fish are pumped up into the reservoir (Brazo, pers. comm. 1979).

MM-7

Muskegon River (43°15', 86°15'). A spawning run enters this river (FWS 1979d).

Pigeon River (42°54', 86°12'). Ripe adults were collected 1 mi S of the Pigeon River; their gonad development suggested that spawning occurred in the fall (Jude and Heufelder, pers. comm. 1979; Jude et al. 1979a). In 1977, gonad development of fish caught in the area from June to November suggested that spawning occurred from late September to November. In 1978, brown trout about 4 in. long were collected in the lake (Jude et al. 1978, 1979a).

MM-8

Palisades Power Plant (42°19', 86°19'). In 1973, ripe and spent adults were collected in the discharge area in October; most were taken when the water temperature was 50-60°F (Consumers Power 1974).

Bridgman (41°56', 86°35'). The gonads of fish collected in this area suggest that spawning occurs here in the lake in the fall. Brown trout less than 4 in. long have been captured in the beach zone (Jude et al. 1975, 1979b).

BROOK TROUT

It is believed that native lake-run brook trout, or "coasters", were eliminated from Lake Michigan in 1956, at about the same time that lake trout were eliminated by the sea lamprey (Becker 1976). Brook trout planted in Lake Michigan since the mid-1960s (Wells and McLain 1973) have produced fall spawning runs in a number of Lake Michigan tributaries.

Wisconsin

WM-1

Menominee River (45°06', 87°35'), Little River (45°03', 87°38'), Peshtigo River (44°58', 87°39'), Oconto River (44°54', 87°50'), Pensaukee River (44°49', 87°54'), Fox River (44°32', 88°00'), and Strawberry Creek (44°49', 87°22'). Spawning runs of stocked fish enter these tributaries (Kernen, pers. comm. 1979).

WM-2

Door Peninsula (45°05', 87°10'). Brook trout enter streams along the Green Bay shore of Door County and streams of Washington Island (45°23', 86°54'), but the water temperature and stream beds are not highly suitable for natural reproduction (Booke and Copes, pers. comm. 1979). Spawning generally occurs in August and September (Kernen, pers. comm. 1979).

WM-4

Ahnapee River (44°36', 87°26') and Kewaunee River (44°28', 87°30') (Kernen, pers. comm. 1979).

East Twin River (44°09', 87°34'), West Twin River (44°09', 87°34'), Manitowoc River (44°05', 87°39'), and Little Manitowoc River (44°06', 87°39') (Hanson, pers. comm. 1979).

Michigan

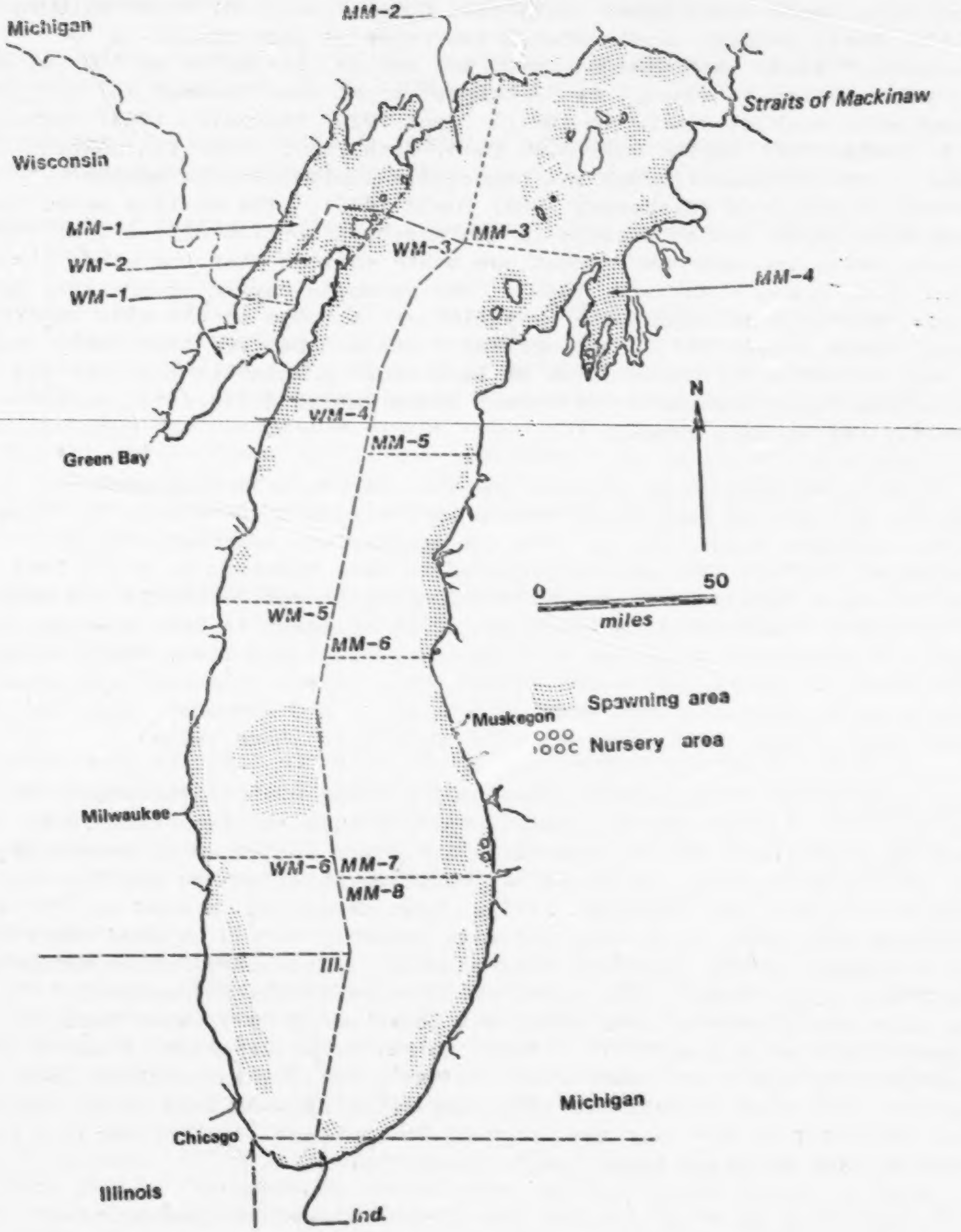
MM-1

Days River (45°54', 86°59') and Whitefish River (45°55', 86°57'). In 1979, coasters entered these rivers in the fall (North Woods Call 1980b).

MM-4

Grand Traverse Bay (45°05', 85°30'). Prior to the 1880s, coasters probably spawned in the streams of Grand Traverse Bay. Spawning occurred in autumn over fine gravel (Price and Kelly 1976).

LAKE TROUT


Michigan
Wisconsin
MM-2
Straits of Mackinaw
MM-1
WM-2
WM-1
MM-3
WM-3
MM-4
WM-4
MM-5
Green Bay
N
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Historically, lake trout were abundant in Lake Michigan. Lake trout moved onto spawning grounds in October (Goode 1884), and spawning lasted from mid-October to early December with a peak in mid-November (Goode 1884; Lagler 1948; Leach 1923; Smith 1909; U.S. Comm. Fish Fish. 1900; Van Oosten and Eschmeyer 1956). Spawning occurred on reefs of honeycombed rock in 3 to more than 200 ft of water, 10-15 mi from shore (Calhoun and Coon 1941; Goode 1884; Leach 1923; U.S. Comm. Fish Fish. 1900; Walburg 1973). Early records distinguished two types of lake trout: a "deepwater" trout that spawned over clay bottom, at depths to 360 ft, and a "shallow water," "shoal," or "Mackinaw" trout that spawned on honeycombed rock at depths to 150 ft (Cook 1929; Eschmeyer 1964; Horrall 1976; Koelz 1926; Smith 1909; U.S. Comm. Fish Fish. 1900; Van Oosten 1944a). The deepwater trout was reportedly limited to the southern portion of the lake (Eschmeyer 1964; Koelz 1926). The shallow water trout spawned on reefs around islands in the northern portion of the lake (Van Oosten 1944a) in September, about one month earlier than the other lake trout (U.S. Comm. Fish Fish. 1900). The spawning habits of the lake trout in northern Lake Michigan were very similar to those of the Lake Superior "lean" trout (Pycha 1978). Commercial fishermen believe that there were as many as seven different races of lake trout present in the lake and that these races spawned at different times and in different locations (Coberly and Horrall 1980a).

Intensive commercial fishing and sea lamprey predation severely depleted the native lake trout stocks in the late 1940s and early 1950s (Pycha and King 1975), and by 1955 the species was near extinction (Eschmeyer 1957b). Extinction occurred in Lake Michigan in about 1956, probably as a result of continued sea lamprey predation (Wells and McLain 1972, 1973). However, lake trout are again abundant in Lake Michigan as a result of extensive plantings of hatchery reared juveniles, which began in 1965 (GLFC, in press; Wells and McLain 1972, 1973). Planted lake trout usually spawn from the last week of October to mid-November, when the water temperature at the bottom falls to 48-54°F (Peck 1979a).

In 1971 and 1972, spawning took place along much of the shoreline of the lake over all substrate types, primarily in water less than 30 ft deep; many of these shallow shoreline areas are subjected to severe wave and ice conditions and therefore may be unsuitable for egg and fry survival (Harris and Eschmeyer 1975). Eggs deposited on sand in 1971 were subjected to severe ice action and were probably buried by sand (Harris and Eschmeyer 1972). In 1975, fish stocked on Milwaukee Reef spawned in Green Bay (GLFC 1976b). The first evidence of successful natural reproduction by planted lake trout was obtained in 1977, when naturally spawned fry were collected from March to May from the water intake of the Traverse City Municipal Power Plant (44°46', 85°37') in northern Lake Michigan (Stauffer 1978a). In 1980, naturally spawned lake trout fry were also collected in May near the Campbell Power Plant (42°55', 86°15') in southern Lake Michigan (Jude, pers. comm. 1980).

Wisconsin

WM-1

Most of the lake trout that spawned here were "reef trout" or "redfins." Substrate on the reefs was various combinations of boulders, gravel, and honeycombed rock (Coberly and Horrall 1980b).

Green Island (45°03', 87°30'). Historically, spawning grounds were located near Green Island (Goode 1884).

Trout Bar (Strawberrys Reef) (45°01', 87°34'). Lake trout spawned here over gravel and honeycombed rock (Coberly and Horrall 1980b).

Youngs Reef (44°54', 87°42'). Spawning occurred here (Coberly and Horrall 1980b).

Sturgeon Bay (44°53', 87°24'). Historically, spawn was collected from ripe adults captured on various spawning grounds (locations unknown) near Sturgeon Bay during the last half of October and early November (Nevin 1901b). Lake trout were planted at Larsens Reef (44°53', 87°29'), between Sturgeon Bay and Little Sturgeon Bay (44°50', 87°33') (GLFC 1976c, 1978; Horrall, pers. comm. 1979), and eggs have been collected from ripe females captured on the reef (WDNR 1972, 1975). Many ripe adults of both sexes and spent females were collected on unnamed reefs just outside Sturgeon Bay (Moore 1970).

Monument Shoal (45°00', 87°22') and Horseshoe Point (45°01', 87°20')--Leroys Point (45°02', 87°19'). Lake trout spawned here (Coberly and Horrall 1980b).

WM-2

Clarks Reef (45°04', 87°19'), Hat Island (45°06', 87°19'), Chambers Island North Reef (45°14', 87°19'), Strawberry Islands (45°10', 87°16'), unnamed reef (45°12', 87°13'), Horseshoe (Eagle) Island (45°11', 87°13'), Sister Shoals (45°12', 87°10'), and Sister Islands (45°13', 87°09'). Lake trout spawned here (Coberly and Horrall 1980b).

Horseshoe Reefs ("the Frying Pan") (45°13', 87°12'). This was a very important spawning ground in the 1930s and 1940s (Copes, Ebener, and Leary, pers. comm. 1979; Frederick, pers. comm. 1979; Horrall, pers. comm. 1979). Fishermen believed this was the most productive lake trout spawning reef in Green Bay (Coberly and Horrall 1980b). The substrate in this area at depths to 30-60 ft is rubble, tablerock, and some honeycombed rock (Horrall, pers. comm. 1979; Marine Studies Center 1978).

West Grounds (45°20', 87°12'--45°15', 87°17'). Lake trout that were caught here during the spawning season were called "salmon trout" or "bay trout." They spawned over sand, gravel, and mud bottom in up to 100 ft of water. These lake trout spawned later than reef trout; spawning began on about November 1 (Coberly and Horrall 1980b).

Honeycomb Reef (45°17', 87°05'). Lake trout spawned here over honeycombed rock (Coberly and Horrall 1980b).

Deathdoor Bluff Reef (45°18', 87°04'). Lake trout spawned here; the substrate is tablerock at depths of 15-35 ft and honeycombed rock at 35-70 ft (Horrall, pers. comm. 1979).

Gills Rock (45°17', 87°02'). Commercial fishermen fished here during the spawning season (Owens, pers. comm. 1979).

Washington Island (45°23', 86°54'). Lake trout spawned along the east shore of the island from 45°24', 86°49'--45°20', 86°50'; around Boyer Bluff (45°25', 86°56'), and on a shoal (45°24', 86°57') on the northwest shore (Coberly and Horrall 1980b).

Six Fathom Reef (45°26', 86°54'), The Little Reef (45°26', 86°47'), Fish Island (45°24', 85°46'), and Fisherman Shoal (45°22', 85°47'). Lake trout spawned here (Coberly and Horrall 1980b).

Waverly Shoal (45°17', 86°57') and Nine Foot Shoal (45°17', 86°57'). These shoals are the northern limits of an extensive series of lake trout spawning reefs that line the east shore of the Door Peninsula (Coberly and Horrall 1980b).

WM-3

Lake trout probably spawned throughout the entire reef area from Europe Bay (45°16', 86°59') to Whitefish Point (44°52', 87°12'); the substrate in this area is gravel, sand, boulders, and honeycombed rock outcroppings. Lake trout were usually taken along the outer edges of the reefs at depths of 30-70 ft. Spawning occurred during mid-October to early December; the run began a week earlier at Whitefish Point than at Baileys Harbor (45°03', 87°07') (Coberly and Horrall 1980b). During the 1930s and 1940s, spawning fish were collected from the ridges of honeycombed rock extending off all the points from Cana Island (45°05', 87°03') south to Jacksonport (44°59', 87°11') (Frederick, pers. comm. 1979). Commercial catches indicated that spawning occurred at the following sites.

Fisherman Shoal Deep Reef (45°20', 86°45') and Spider Island (45°13', 86°59') (Coberly and Horrall 1980b).

Four Foot Shoal (45°10', 87°00') (Coberly and Horrall 1980b; Frederick, pers. comm. 1979).

Cana Island (Sucker Reef) (45°05', 87°03'). This appeared to be one of the most productive areas, based on the number of boats fishing there (Coberly and Horrall 1980b).

Baileys Harbor (45°03', 87°07'). Spawners were historically collected from the five ridges of honeycomb extending from the harbor (Frederick, pers. comm. 1979). Black Stake Reef (45°03', 87°05') was one of the most productive areas, based on the number of boats fishing there. Fishermen from as far away as Two Rivers (44°09', 87°34') came to the Baileys Harbor area to collect spawn in the fall (Coberly and Horrall 1980b).

Jacksonport (44°59', 87°11'). Jacksonport Reef (45°02', 87°06'--44°57', 87°10') and Jacksonport Deep Reef (44°57', 87°03') were identified as spawning sites (Coberly and Horrall 1980b; Frederick, pers. comm. 1979). Cardys Reef in the same area was exceptionally productive, but fishermen disagreed on its exact location (Coberly and Horrall 1980b).

Whitefish Bay (44°54', 87°12'). Spawning occurred on the rocky areas off Cave Point (44°56', 87°10') (Copes, Ebener, and Leary, pers. comm. 1979). Whitefish Point Reef (Red Stake) (44°52', 87°11') was a major spawning ground (Coberly and Horrall 1980b; Frederick, pers. comm. 1979; Horrall, pers. comm. 1979); substrate here was honeycombed rock and boulders (Coberly and Horrall 1980b). This area included a site called Sy's Reef (Coberly and Horrall 1980b). Spawning may presently occur at Whitefish Point Reef (Copes, Ebener, and Leary, pers. comm. 1979). The Spits (44°54', 87°10'), a 16 ft deep shoal at the mouth of Whitefish Bay, is an historical spawning ground (Coberly and Horrall 1980b; Horrall, pers. comm. 1979).

Lily Bay Shoals (44°51', 87°13'--44°49', 87°16'), Allies Reef (44°48', 87°13'), and Black Can Reef (44°45', 87°18') (Coberly and Horrall 1980b).

Sturgeon Bay Ship Canal (44°48', 87°19'). Eggs were collected in late October from ripe fish captured over a reef area just south of the entrance to the canal (GLFC 1976c).

Clay Banks (44°42', 87°20'). This is an historical spawning area; the substrate is rubble and honeycombed rock (Coberly and Horrall 1980b; Horrall, pers. comm. 1979). In the late 1800s, fishing for spawners occurred over a rocky bottom, to depths of 60-84 ft, in an area extending 2 mi N and S of the town of Clay Banks (44°43', 87°21') (Kumlien and True 1887).

WM-4

Stony Creek Reef (44°40', 87°19') (Coberly and Horrall 1980b). This was a fishing ground for spawners during the late 1800s (Kumlien and True 1887).

Algoma (44°37', 87°26'). Spawning lake trout were caught on Gaulkes Reef (44°37', 87°24'), Braemmers Reef (44°36', 87°25'), Eleven Fathoms Reef (44°35', 87°23'), and Kewaunee Hill (44°36', 87°26') (Coberly and Horrall 1980b).

Kewaunee (44°27', 87°30'). Kewaunee Shoal (44°27', 87°28') was identified as an historical spawning ground by fishermen (Coberly and Horrall 1980b).

Kewaunee Power Plant (44°21', 87°32'). This area may be a spawning ground (Ind. Bio-Test 1972). Impingement at the plant indicates that an onshore migration occurs from September to December (NALCO, undated b). Ripe-running adults were found throughout the area near the plant, from September to November, at depths of about 15-20 ft, over a substrate of hard clay, rubble, and cobble (Ind. Bio-Test 1972; LaJeone 1976, pers. comm. 1979).

Point Beach Power Plant (44°17', 87°32'). There are large influxes of adults into the area during September and October. In 1976, catches in the latter part of September at water temperatures of about 55-61°F suggest that fish move into nearshore areas prior to spawning; larger catches in October suggest that spawning may occur in the vicinity (Wis. Elec. Power, undated; Wis. Elec. Power and Wis.-Mich. Power, undated c).

Pine Creek (43°59', 87°42'). A "big redfin" trout spawned on the honeycombed rock reef (44°01', 87°39'--43°59', 87°41') off the creek mouth (Coberly and Horrall 1980b).

WM-5

Haven (43°51', 87°44'). An influx of ripe-running adults occurs here during October and November; highest concentrations of fish occur at depths of about 15-20 ft over a substrate of rocks, cobbles, and boulders overlying hard clay (Ind. Bio-Test 1977; LaJeone, pers. comm. 1979). Surveys conducted with pumps found no lake trout eggs in the area (LaJeone, pers. comm. 1979).

Sheboygan (43°45', 87°42'). Lake trout are most abundant in the vicinity of the Edgewater Power Plant (43°43, 87°42') during October, but spawning is not expected here due to the lack of silt-free rock substrate (Swanson Environ. 1979).

Port Washington (43°23', 87°52'). Ripe males and mature females were collected in mid-October at the beginning of the spawning run over rock and rubble in an area (43°22', 87°52'--43°16', 87°53') extending S for about 8 mi from Port Washington and offshore to a depth of about 90 ft (Eck, pers. comm. 1979). Most adults impinged in the fall at the Port Washington Power Plant (43°23', 87°52') were in spawning condition; these fish were most abundant in late October (Wis. Elec. Power 1976e).

Milwaukee-Sheboygan Reef Complex (43°20', 87°10'--42°59', 87°10'). Historically, this reef system, including Milwaukee (42°59', 87°05'--43°11', 87°20'), Sheboygan (43°14', 87°10'--43°27',87°10'), Northeast (43°20', 87°30'--43°08', 87°32') and East (43°10', 87°28'--43°00', 87°21') reefs, was the major spawning ground in the lower two-thirds of the lake for the native deepwater lake trout (Coberly and Horrall 1980b; Daly et al. 1962; Goode 1884; Harris and Eschmeyer 1975; Horrall 1976; Poff et al. 1964). Almost every commercial fisherman recently interviewed referred to this area, and to Sheboygan Reef in particular, as the most important spawning ground in the entire lake (Coberly and Horrall 1980b). From the 1930s to the late 1940s, spawning occurred here in 120-260 ft of water over clay with patches of rock, honeycombed rock, and clinkers from mid-October to mid-November (Coberly and Horrall 1980b; Organ et al. 1978). Because of its historical productivity, plantings have been made on the reef (Brown 1977; GLFL 1970, 1972, 1973). During surveys in 1973 and 1974, several ripe or nearly ripe adults were collected on the shallowest portion of Milwaukee Reef (138 ft) in late October and early November (Wells 1975).

Milwaukee (43°02', 87°54). In the late 1800s, spawning lake trout were fished in the fall on a small reef (location unknown) 6 mi off Milwaukee (Goode 1884; Kumlien and True 1887). This may be the same area (43°05', 87°45'), about 6 mi E of North Point (43°04', 87°52'), where a commercial fisherman collected spawn from ripe fish over sand and clay in 120-138 ft of water (Coberly and Horrall 1980b). Planted lake trout presently begin moving onshore at the end of September, when water temperatures are about 41°F at the bottom and 59°F at the surface; spawning begins in about the last week of October (Norden, pers. comm. 1979). In the 1970s, ripe-running males and females were netted from mid-October to mid-November in the area between Whitefish Bay (43°08', 87°53') and Bradford Beach (43°04', 87°52') in 30-40 ft of water over a hard bottom of clay, rubble, cinders, and boulders. The abundance of ripe adults suggests that spawning occurs in the area between Atwater Beach (43°05', 87°52') and North Point (43°04', 87°52') (Binkowski and Yeo, pers. comm. 1979). Slimy sculpins that had eaten lake trout eggs were also collected in this vicinity (Binkowski and Yeo, pers. comm. 1979; Norden, pers. comm. 1979).

Milwaukee (43°02', 87°53')--Oak Creek Harbor (42°51', 87°50'). "Yellow-fins," "yellow-bellies," and "reefers" spawned on the shoals throughout this area during October 10 to November 15. Spawning also occurred on the reef (42°58', 87°47') about 4 mi E of Cudahy (42°57', 87°51') (Coberly and Horrall 1980b).

WM-6

Deepwater trout spawned throughout the area about 10 mi offshore from Racine (42°44', 87°47') south to Chicago (41°53', 87°37') (Coberly and Horrall 1980b).

Wind Point (42°47', 87°45'). Lake trout spawned on North Shoal (43°48', 87°44') and South Shoal (42°46', 87°44'), which form Bullshit Reef (Coberly and Horrall 1980b).

Racine Reef (42°44', 87°45'). This was a spawning ground before the sea lamprey became established in the lake (Ver Duin 1974, as cited in Horrall 1976).

Illinois

Some of the early literature indicates that no areas in the Illinois waters of Lake Michigan were recognized as lake trout spawning grounds; the grounds were reported to begin south of Racine (42°44', 87°47') and to extend north along the entire lake shore (Goode 1884; Milner 1874a). Waukegan (42°22', 87°50'), however, was a site of spawn collection (Nevin 1899). Deepwater trout were caught by Illinois fishermen in 198-270 ft of water in a wide band from the Wisconsin state line (42°29', 87°48') across the southern portion of the lake and into Michigan waters. Deepwater trout spawned from October 20 to late November; peak spawning occurred in mid-November (Coberly and Horrall 1980a).

A geological survey of the shoreline platform extending from the Great Lakes Naval Training Center (42°18', 87°50') south to Indiana Harbor (41°40', 87°25') located more than 100 shallow reefs and small prominences with physical characteristics that may be able to support spawning by the shallow water variety of lake trout that is presently stocked. Most of the reefs are small exposures of dolomite bedrock with patches of gravel and cobble, honeycombed rock structures and cavities, and an occasional thin covering of glacial till (Collinson et al. 1979). Most of these reefs lie in offshore waters in the area between Zion and Evanston, bounded generally by longitudes 87°45' and 87°25' and by latitudes 42°05' and 42°30', at optimum depths of 50-100 ft. A second area adjacent to and east of the first area contains several bedrock reefs at depths of 100-200 ft; its potential as a spawning ground is believed to be slightly less than that of the first area (Norby and Collinson 1977). Patches of gravel occurring intermittently along the entire Illinois shore should also provide good spawning habitat and protection for eggs. Several of these areas have been identified at the 30 ft depth east of Evanston (Norby and Collinson 1977).

North Grounds (42°24', 87°35') and Middle Grounds (42°22', 87°30'). These areas, 12 1/2 mi NE and 16 mi E of Waukegan (42°22', 87°50'), respectively, were spawning grounds for deepwater lake trout. The substrate was a combination of sand, silt, clay, and mud (Coberly and Horrall 1980a).

South Grounds (42°14', 87°30'). This area, 20 mi SE of Waukegan (42°22', 87°50') was the most productive site for deepwater trout; catches of 5,000 lbs per net gang were made consistently during the spawning season. The substrate was a combination of sand, silt, mud, and clay (Coberly and Horrall 1980a).

Waukegan Reef (42°21', 87°38') and Highland Park Reef (42°11', 87°43'). Ripe lake trout are returning to planting sites here in mid-September and October (Muench, pers. comm. 1979). Both of these reefs have been studied to determine their potential for reproduction. Minimum water depth is 126 ft on Waukegan Reef and 22 ft on Highland Park Reef (Collinson et al. 1979).

Lake Bluff 18-Mile Reef (42°18', 87°28'). This is a potential spawning area. The reef is a mound of glacial till covered with sand and clay; it lies in 250-255 ft of water, and the minimum water depth on the reef is 40 ft (Collinson et al. 1979).

Fort Sheridan Nearshore Bedrock Platform (42°14', 87°47'). This area is a potential spawning area. It extends along the shoreline from the north end of Forest Park in Lake Forest (42°15', 87°49') to the municipal waterworks in Highland Park (42°11', 87°47') and to the 70 ft depth contour about 9 mi offshore. The substrate is mainly dolomite with scattered patches of sand and gravel (Collinson et al. 1979).

Julian's Reef (42°13', 87°32'). During the 1940s, this area, 14 1/2 mi E of Fort Sheridan (42°13', 87°48'), was a very productive spawning ground for reef trout; as many as 11,400 lbs of lake trout, mainly "redfin" trout, were taken in one net set. This was one of the last reefs in Lake Michigan known to support spawning of native lake trout; the spawning stock using Julian's Reef was depleted by 1945 (Coberly and Horrall 1980a; Collinson et al. 1979; Muench, pers. comm. 1979). A fishery survey conducted in 1952 took only one native adult on the reef during the spawning season (Muench, pers. comm. 1979). The last reported catch of native trout in Illinois also occurred in 1952 (Coberly and Horrall 1980a). Reef trout also spawned on a small unnamed reef (42°13', 87°32') just west of Julian's Reef (Coberly and Horrall 1980a).

Wilmette (Glencoe) Reef (42°08', 87°35') and Grossepoint Reef (42°08', 87°27'). These are potential spawning areas for lake trout. Wilmette Reef lies in 60-80 ft of water; the southeast slope is relatively steep and irregular with gravel on the lower slopes and offers the best possibility for spawning. Grossepoint Reef has a minimum water depth of 117 ft, and its slopes and surface irregularities are favorable for spawning (Collinson et al. 1979).

Evanston (42°03', 87°40'). In 1979, a few nearly ripe females were collected in August about 3 mi offshore in 30 ft of water; a few running-ripe males and a nearly ripe female were collected here in mid-October (Janssen, pers. comm. 1979). Northwestern Reef (42°03', 87°35') is a potential spawning area; the substrate is bedrock, and minimum water depth on the reef is 41 ft (Collinson et al. 1979).

Indiana

Until the 1940s, lake trout were fished along the Indiana shoreline at depths of 80-120 ft in November (Westerman, pers. comm. 1979).

East Chicago (41°39', 87°26'). Lake trout are stocked at Joerse Park (41°39', 87°26'); concentrations of ripe adults are found in October and November, but there is no evidence of natural reproduction here (Koch, pers. comm. 1979).

Gary (41°37', 87°20'). Adults in spawning condition have been found near the Mitchell Power Station (41°38', 87°22') in November, but there is no evidence of natural reproduction (NALCO 1976a).

Burns Waterway Harbor (41°38', 87°09'). Lake trout are now stocked at the mouth of the harbor, and concentrations of ripe adults are found here in October and November (Koch, pers. comm. 1979). Concentrations of adults are also found in the fall near the Bailly Generating Station (41°39', 87°07'), about 1 mi E of the harbor (Tex. Instrum. 1975b, 1977b).

Spawning occurs over limestone rock along the west wall of the outer basin of the Burns Waterway Harbor, but there is no evidence of successful natural reproduction (Koch, pers. comm. 1979).

Michigan City (41°43', 86°54'). Lake trout are stocked here (Koch, pers. comm. 1979). Spawning occurs in an area (41°42', 86°57') about 2 mi W of Michigan City from near shore out to a depth of about 50 ft; large concentrations of ripe-running and spent adults are collected here beginning in the last week of October, and spawning lasts to mid-November (Koch, pers. comm. 1979; McComish, pers. comm. 1979). Windrowed eggs have been observed in the area from the Indiana Dunes (41°40', 87°02') to the Michigan state line (41°46', 86°49') after a north wind (McComish, pers. comm. 1979).

Michigan

MM-1

Birch Point Reef (location unknown; possibly off Birch Creek, 45°11', 87°34'). Historically, spawning occurred here in November (Van Oosten 1927a).

Beattie Creek (43°14', 87°31'). Lake trout spawned in an area (45°13', 87°30') off the creek mouth over rocky substrate in 18-40 ft of water (Organ et al. 1978).

Arthur Bay (45°19', 87°26'). From the 1920s to the 1950s, lake trout spawned in an area (45°19', 87°25'--45°20', 87°24') over rock and gravel (Organ et al. 1978).

Whaleback Shoal (45°21', 87°11'). This is an historical spawning area where fishermen collected spawn (Coberly and Horrall 1980b; Frederick, pers. comm. 1979; Horrall, pers. comm. 1979). From 1915 to the 1950s, spawners were caught here over rock and gravel in about 30 ft of water (Organ et al. 1978).

Sugar Creek (45°22', 87°23'). Two reef areas (45°22', 87°22' and 45°21', 87°23') off the mouth of Sugar Creek are historical spawning areas; these presently have poor reproductive potential (Peck 1979a).

Cedar River (45°24', 87°21'). During the 1920s to 1950s, native lake trout spawned from the mouth of the Cedar River to Deadmans Point (45°26', 87°20') over rock and gravel at a depth of about 24 ft. In 1978, planted lake trout spawned at the river mouth (Organ et al. 1978).

Bakers Reef (45°28', 87°18') and Halsteads Reef (45°32', 87°15'). These are traditional spawning areas; both now have poor reproductive potential based on the catch of very few mature planted fish (Peck 1977, 1979a).

Ford River (45°40', 87°08'). A stream-run population, which resulted from an unintentional plant in 1969, enters the river mouth in October, but the success of reproduction is unknown (Becker 1976).

Round Island Reef (45°38', 87°10') and North Round Island (45°38', 87°10'). These are historical spawning grounds. Round Island has excellent reproductive potential based on the collection of several ripe and spent males and females in October and November 1975 and 1976 (Peck 1976, 1977, 1979a; Rybicki and Keller 1976).

Stonington Reef (45°43', 86°59'). This is an historical spawning area; in 1976, several ripe males were found here in mid-October, and the reproductive potential is considered fair (Peck 1977, 1979a). Spawning also occurred (no dates given) off the mouth of the Escanaba River (45°47', 87°03') (Organ et al. 1978).

Corona (45°37', 86°58'), Eleven Foot (45°38', 86°59'), Peninsula Point (45°40', 86°58'), and Minneapolis Shoals (45°35', 87°00'). Lake trout spawned over rock and sand here (Organ et al. 1978; Peck 1979a). Surveys have found few mature fish present in these areas during the spawning season, and reproductive potential is considered poor (Peck 1979a). Only one spent and two ripe males were found at Eleven Foot Shoal in 1975 (Peck 1976).

Big Bay de Noc (45°45', 86°45'). Spawning occurred in this area from mid-October to late October or mid-November (Van Oosten 1927a).

Rocky Island (45°37', 86°43'). Since 1915, lake trout have spawned on the rock shoal west of the island (Organ et al. 1978). [Author's note: Native lake trout were extinct in Lake Michigan by about 1956 (Wells and McLain 1972, 1973). Hatchery reared juveniles were not planted in Lake Michigan until 1965 (GLFC, in press; Wells and McLain 1972, 1973) and would probably not have spawned before 1970.]

Poverty Island Shoal (45°33', 86°42'), Gravelly Island (45°31', 86°44'), Gravelly Island Shoals (45°32', 86°44'), Gull Island (45°31', 86°43'), and Little Gull Island (45°30', 86°43'). From 1915 to the 1950s, lake trout spawned over rock and gravel here (Organ et al. 1978).

Poverty Island (45°32', 86°40') and the shoal south of Summer Island (45°32', 86°39'). Lake trout spawned here (no dates given) over rock (Organ et al. 1978).

St. Martin Island (45°30', 86°46'). Historically, fishermen collected spawn from ripe lake trout here (Frederick, pers. comm. 1979). From 1915 to the 1950s, spawning occurred on the St. Martin Island Shoals (45°27', 86°46') over rock and gravel (Organ et al. 1978).

MM-2

Kregg Bay (45°42', 86°34'). Lake trout spawned on the rock shoal (45°41', 86°31'), about 2 mi E of the bay (Organ et al. 1978).

Parent Bay (45°47', 86°25'). Spawning occurred on the rock shoal on the west side of the bay (Organ et al. 1978).

Point aux Barques (45°48', 86°21'). Spawning occurred here in late October to mid-November (Van Oosten 1927a). Native lake trout spawned here over rock and gravel until the 1940s; the earliest reported catch of spawners was in 1915 (Organ et al. 1978). In 1976, only one ripe fish of each sex was captured here in late October, and the reproductive potential is poor (Peck 1977, 1979a).

Wiggins Point Shoal (45°51', 86°18'). Native lake trout spawned here over rock and gravel (Organ et al. 1978).

Manistique (45°57', 86°15'). From the 1930s to 1947, native lake trout spawned about 3 mi S of the mouth of the Manistique River (45°57', 86°15') over a rocky shoal (45°54', 86°15') at a depth of 23 ft. During the 1970s, planted fish spawned along the rocky shoreline for about 1 mi on each side of the river mouth (Organ et al. 1978).

MM-3

Seul Choix Point (45°55', 85°55'). Spawning historically occurred around the point in November (Organ et al. 1978; Van Oosten 1927a). In 1976, a few ripe adults were caught here in late October, but the reproductive potential is considered poor (Peck 1977, 1979a).

Hughes Point (45°58', 85°50'). Until 1948, native lake trout spawned about 5 mi S of the point over a rock shoal (45°54', 85°50') at a depth of 36 ft (Organ et al. 1978).

Boulder Reef (45°36, 85°58'). This is an historical spawning ground (Peck 1979a); spawning occurred here until about 1948 (Organ et al. 1978).

Gull Island (45°42', 85°50'). Gull Island Reef (45°38', 85°48') is an historical spawning ground (Peck 1979a); spawning occurred here until about 1948 (Organ et al. 1978). During the 1920s, spawning occurred on the shoal area (45°41', 85°51') off the southwest point of Gull Island (Organ et al. 1978).

Richards Reef (45°34', 85°44'). This rock and rubble reef is an historical spawning ground (Peck 1979a); in 1975, planted trout spawned here (Organ et al. 1978). In 1975, a few ripe and spent adults were found here in late October, but reproductive potential is considered poor (Peck 1976, 1979a).

Trout Island Shoal (45°47', 85°44'). This is an historical spawning ground (Peck 1979a); spawning occurred here until about 1948 (Organ et al. 1978).

High Island (45°44', 85°40'). This is an historical spawning ground (Peck 1979a).

Naubinway (46°06', 85°27'). Native lake trout historically spawned at Naubinway on October 8-20 and at Naubinway Reef (46°03', 85°26') on October 10-20 (Peck 1979a; Van Oosten 1927a). In 1975, planted lake trout spawned at Naubinway Island (46°04', 85°27') over rock and sand (Organ et al. 1978).

Whiskey Island Shoal (45°48', 85°38'). This is an historical spawning ground (Peck 1979a).

Beaver Island (45°40', 85°33'). Beaver Harbor (45°44', 85°30'), at the north end of the island, and "Head of the Beavers" (45°34', 85°36'), at the south end, are historical spawning grounds (Peck 1979a). Trout were also taken in large numbers in the fall at "Middle Ground" (precise location unknown), a ledge in 48-60 ft of water half way between Beaver Island and North Fox Island (45°29', 85°47') (Smith and Snell 1891). Spawning occurred in this area on about November 1 (Strang 1855); spawn was collected from ripe fish here during October and November (Ravenel 1898).

Lansing Shoals (45°55', 85°35'). In 1942-43, lake trout spawned here (Organ et al. 1978).

Garden Island Shoal (45°52', 85°29'). Native lake trout spawned here during October (Organ et al. 1978; Van Oosten 1927a).

Mille Coquins Reefs (46°00', 85°27') and Potter Reef (46°00', 85°32'). Native lake trout spawned here on October 5-20 (Organ et al. 1978; Peck 1979a; Van Oosten 1927a).

Hog Island (45°47', 85°22'). Hog Island Reef (45°44', 85°21'), about 4 mi S of the island, is an historical spawning ground (Peck 1979a); in the 1920s, spawning occurred here during October (Organ et al. 1978; Van Oosten 1927a). The north end of Hog Island and the Hog Island Humps (location unknown) were spawning areas (Van Oosten 1927a), as were Horseshoe Reef (45°46', 85°20') and Hat Island (45°49', 85°18') (Peck 1979a).

Joe Smith Reef, Five Mile Reef, and Metty Outer Reef (locations unknown). Lake trout spawned on these reefs in mid-October (Van Oosten 1927a).

Epoufette (46°03', 85°10'). Spawn was collected near Epoufette during October and November (Ravenel 1898). Spawning occurred at Epoufette from October 10 to November 1 and on Pelkie Reef (46°02', 85°15') on October 10-20 (Van Oosten 1927a).

Manitou Paymen Shoal (45°58', 85°04'), Simmons Reef (45°55', 85°12'), and Fagan Reef (45°57', 85°18'). Spawning occurred at these locations on October 10 to November 1 (Van Oosten 1927a). Native lake trout spawned at Manitou Paymen, Fagan Reef, and Simmons Reef until the 1950s, and planted fish have spawned at Manitou Paymen (Organ et al. 1978).

Cross Village (45°39', 85°02')--Good Hart (45°34', 85°07'). The nearshore reefs directly off Cross Village and Good Hart are historical spawning grounds as are Ile aux Galets (45°41', 85°10') and Dahlia Shoal (45°38', 85°12') (Peck 1979a). During the 1920s, spawning occurred at Ile aux Galets in October (Van Oosten 1927a). At Dahlia Shoal, spawning occurred over honeycombed rock during the 1920s and in 1973-75 (Organ et

1973 and 1975, a few ripe males were found here in November (Peck 1974b, 1976). Spawning also occurred on a rock shoal (45°16', 85°58') at depths of 60-75 ft deep about 8 mi W of the southern tip of the South Fox Island Shoals (Organ et al. 1978).

MM-4

Grand Traverse Bay (45°05', 85°30'). Lake trout were most plentiful here from October 10 to November 10 and were almost the only fish taken at this time (Smith and Snell 1891).

> Norwood Reef (45°13', 85°24'). This reef is an historical spawning ground (Peck 1979a); during 1930-50 spawning occurred over rock, to depths of 50-60 ft (Organ et al. 1978).
>
> Traverse Shoal (45°08', 85°26'). This rock and rubble area is a traditional spawning ground (Peck 1979a). Spawning occurred over honeycombed rock here during 1935-50 (Organ et al. 1978. Lake trout have been planted here (Rybicki and Keller 1978), and spawning fish are generally abundant in the area (Rybicki et al. 1975). Spawning occurred here in 1975 (Organ et al. 1978). In 1973-76, ripe and spent males and females were present from late October to mid-November, and in 1973 and 1974 eggs were found in the stomachs of lake trout captured here; the reproductive potential here is fair (Peck 1974, 1975b, 1976, 1979a; Rybicki et al. 1975; Rybicki and Keller 1978).
>
> Elk River (44°54', 85°25'). Construction of a dam here in 1851 blocked the upstream spawning migration of lake trout in this tributary to the bay (Price and Kelly 1976).
>
> Old Mission Point Reef (45°02', 85°29'). This is an historical spawning ground (Peck 1979a). In the 1920s, spawning occurred during November at Old Mission Reef (probably Old Mission Point Reef) and Old Mission Point Shoal (45°01', 85°29') (Van Oosten 1927a).
>
> Tucker Point (44°54', 85°34'). This is an historical spawning ground; in 1976, only one mature male was found, and the reproductive potential is presently considered poor (Peck 1979a).
>
> Bowers Harbor (44°54', 85°32'). This is an historical spawning ground; the substrate is boulders, cobbles, pebbles, and sand (Peck 1979a). In 1975, planted trout spawned around the harbor shore (Organ et al. 1978). In 1976, spawning males and females were found here in early November, live eggs were subsequently collected off the bottom, and the reproductive potential is good (Peck 1979a; Stauffer and Peck 1977); however no live eggs or fry were found the following spring (Stauffer and Peck 1977). Spawning is believed to occur in the middle portion of the head of the harbor at a depth of 8-15 ft over gravel and rounded rock, 6-12 in. diameter, with patches of sand, large boulders, and silt (Stauffer and Peck 1977).

Marion Island (44°52', 85°35'). The boulder and sand reef at the south end (44°51', 85°36') of the island and the cobble and boulder reef at the north end (44°53', 85°34') of the island are historical spawning grounds (Peck 1979a). In 1975, planted lake trout spawned on the north reef (Organ et al. 1978). In 1976, a few mature males were collected on the south reef in late October, and the reproductive potential is fair. More mature adults of both sexes were found at the north reef, and the reproductive potential is considered excellent (Peck 1979a).

Traverse City (44°46', 85°37'). Historically, lake trout may have spawned in nearby tributaries to the bay; the dam built in 1847 on Kid's Creek (44°46', 85°38') blocked the lake trout spawning migration (Price and Kelly 1976). In 1897, spawn of lake trout or whitefish, or both, was collected from a tributary (location unknown) of the bay (Ravenel 1898). In 1975, planted trout spawned over rock in an area (44°46', 85°38') just west of the Boardman River (44°46', 85°37') and in another (44°47', 85°38'--44°47', 85°39') directly off Greilickville (44°47', 85°39') to depths of 50-60 ft (Organ et al. 1978). In 1977-78, evidence of successful natural reproduction in the Traverse City area was found (Rybicki and Keller 1978). In 1977, lake trout fry were found in the intake water of the Traverse City Municipal Power Plant (44°46', 85°37') during March to May, and live eggs were found in November and December in 30 ft of water about 1,500 ft offshore, on the 2-6 in. diameter rocks in the power plant intake crib and on the rock spilling from the crib. These eggs were ready to hatch in mid-April 1978, but no fry were found (Stauffer 1979a). Live eggs were also found here in late November 1978 (Stauffer 1979b). In 1977, live eggs were also found in November on the outside of the southeast rock and rubble breakwall of the Elmwood Marina (44°47', 85°38'); no live eggs were found there in April 1978, but many fry were collected in late May and June (Stauffer 1978a). In 1978, live eggs were collected at the Elmwood Marina in late November; in 1979, fry about 1 in. long were collected from May 2 to July 2. In 1979, anglers reported a concentration of spawners at the Clinch Park Marina (location unknown), but few live eggs and no fry were found there (Stauffer 1979b).

Lee Point (44°56', 85°36'). Moss trout spawned over honeycombed rock and moss on the shoal (44°54', 85°37') about 2 mi S of Lee Point (Organ et al. 1978).

Suttons Bay (44°59', 85°37'). Moss trout spawned over rock and moss in an area (45°00', 85°38') on the west side of Suttons Bay (Organ et al. 1978). Suttons Point Reef (45°00', 85°36') is an historical spawning ground (Peck 1979a). In 1975, planted fish spawned on the reef over rock and rubble (Organ et al. 1978); in 1976 many mature adults were found here, and the reproductive potential is excellent (Peck 1979a).

New Mission Point (45°03', 85°34'). The boulder and cobble reef off the north side (45°04', 85°34') is an historical spawning ground (Peck 1979a). In 1975, planted lake trout spawned here (Organ et al. 1978). The substrate consists of 4-15 in. diameter rock rubble with patches of sand and large boulders. A rock ridge extends to the northeast to at least the 50 ft depth contour and contains crevices 3-14 in. deep. Lake currents apparently keep the top of the ridge free of silt (Stauffer and Peck 1977). In 1976, several spawning adults were found here in late October, live eggs were subsequently pumped from the bottom, and the reproductive potential is excellent (Peck 1979a; Stauffer and Peck 1977); however no live eggs or fry were found the following spring (Stauffer and Peck 1977). "Moss" trout spawned over rock and moss near the 30 ft depth contour in an area (45°02', 85°35') on the west side of New Mission Bay (Organ et al. 1978).

Bellow Island (45°06', 85°34'). This boulder and cobble area is an historical spawning ground (Peck 1979a). In 1975, planted lake trout spawned around the island and on the shoals (45°07', 85°34') north of the island (Organ et al. 1978). In 1976, several ripe adults were found at the island in late October, and the reproductive potential is excellent (Peck 1979a; Stauffer and Peck 1977). The substrate consists of 6-12 in. diameter rock rubble arranged in a series of ridges, 6-10 ft across, with crevice depths greater than 10-14 in. (Stauffer and Peck 1977).

Northport Point (45°08', 85°33'). The rock and rubble reef here is an historical spawning ground (Peck 1979a). Until 1940, lake trout spawn was collected in the Northport (45°08', 85°37') area (Westerman 1940). In 1975, planted fish spawned on the shoals along the entire east side of the point (45°10', 85°33'--45°08', 85°33') (Organ et al. 1978). In 1976, mature adults were found here in early November, and the reproductive potential is considered good (Peck 1979a).

MM-5

Lighthouse Point (45°13', 85°33')--Cat Head Point (45°11', 85°37'). During the 1920s, spawning occurred in November at Lighthouse Reef and Lighthouse Point Shoal (locations unknown) and Cat Head Point (Van Oosten 1927a). The areas east and northeast of Lighthouse Point were identified as one of the greatest spawning grounds in the lake (Kumlien and True 1887). Cat Head Point Reef (45°12', 85°35'), in Cat Head Bay (45°11' 85°36'), is an historical lake trout spawning ground (Peck 1979a).

Leland (45°01', 85°46'). Lake trout spawned (no dates given) over the rock reef (45°02', 85°46'--45°05', 85°43'), extending about 5 mi N from Leland (Organ et al. 1978); this may be the "North Reef" fished out of Leland in the 1920s, where spawning occurred from late October to late November (Van Oosten 1927a). Spawning also occurred north of Leland Green

Woods (location unknown) during November and 8 mi N (precise location unknown) of Leland (Van Oosten 1927a). Until 1940, spawn was collected in the Leland area (Westerman 1940).

Manitou Islands (45°04', 86°03'). This area is an historical spawning ground (MSBFC 1893). During the 1920s, spawning occurred at North (45°07', 86°01') and South (45°01', 86°08') Manitou islands from late October to late November (Van Oosten 1927a); in the 1930s, spawning occurred on the rock, gravel, and clay shoals surrounding both islands and on the North Manitou Shoals (45°02', 85°58') (Organ et al. 1978).

Good Harbor Reef (44°59', 85°49'). This is an historical spawning ground (Peck 1979a), and may be the "South Reef" fished out of Leland (45°01', 85°46') in the 1920s, where spawning occurred from late October to late November (Van Oosten 1927a). Lake trout were planted on this reef during the 1970s, and some fish have returned here to spawn (North Woods Call 1979c; Rybicki and Keller 1978).

Pyramid Point (44°58', 85°56'). Spawning occurred on Pyramid Point Reef (Shoal) (44°59', 85°55') (Peck 1979a) in November (Van Oosten 1927a). Lake trout spawned (no dates given) over rock (45°01', 85°55') directly north of Pyramid Point Shoal in about 30-60 ft of water and on the rock reef (44°56', 85°59') along the west side of the point, just north of Sleeping Bear Bay (44°55', 86°00') (Organ et al. 1978).

Sleeping Bear Point (44°55', 86°03')--Point Betsie (44°42', 86°15'). During the 1920s, lake trout spawned during November at Sleeping Bear Reef (Shoal) (44°54', 86°05') Empire Reef (44°48', 86°07'), and Platte River Reef (44°44', 86°09') (Van Oosten 1927a).

MM-6

Arcadia (44°30', 86°14'). In the late 1800s, lake trout spawned on a reef area (location unknown) about 4 mi from Portage Lake (44°22', 86°14') (Smith and Snell 1891). In the 1920s, spawning occurred on "Arcadia Reef" (location unknown) and on a small reef (location unknown) off Arcadia during November (Van Oosten 1927a). During the 1930s-50s, spawning occurred on the reef area (44°25', 86°18'--44°28', 86°18') about 4 mi SW of Arcadia over honeycombed rock at a least depth of 29 ft (Organ et al. 1978); this is probably the same location identified by Smith and Snell (1891) and Van Oosten (1927a).

Portage Lake (44°22', 86°14'). During the 1930s-50s, lake trout spawned on the 30 ft deep rock reef (44°22', 86°17') about 2 mi off Portage Lake (Organ et al. 1978).

Manistee (44°15', 86°20')--Little Sable Point (43°39', 86°33'). Lake trout have been stocked at Manistee and Ludington (Rybicki and Keller 1978), and planted fish spawn along the entire shoreline from Manistee to Little Sable Point, over rock and gravel to a depth of about 50-60 ft (Organ et al. 1978). During the 1930s and 1940s, native lake trout also spawned in a nearshore area (44°11', 86°24') with gravel bottom about 6 mi SW of Manistee and in a rock area (43°55', 86°30'), about 4 mi SW of Ludington, at depths of about 50-70 ft (Organ et al. 1978). Native lake trout spawned at the "Ludington clay banks" (location unknown) from November 10 to December 10 and at a "small spot of rocks" 6 mi S of Ludington (43°57', 86°28') (Van Oosten 1927a). Spawning occurs in an area (43°52', 86°29') about 6 mi S of Ludington over rock and clay in 40-70 ft of water; this location may be the same rock area identified as a spawning ground for native lake trout by Van Oosten (1927a). Spawning also occurs in an area (43°54', 86°30') directly west of the Ludington Pumped Storage Plant (43°54', 86°27') over clay bottom in 70-90 ft of water (Brazo, pers. comm. 1979; Organ et al. 1978); this location may be the clay banks identified by Van Oosten (1927a). Spawning occurs here slightly later than it does in nearshore areas (Brazo, pers. comm. 1979). During the 1970s, large numbers of ripe lake trout were collected in an area (43°52', 86°27'--43°55', 86°27') extending from 1/2 mi S to 1/2 mi N of the plant, as they moved inshore from mid-September to mid-November; many partly spent and fully spent fish were present by mid-November (Brazo, pers. comm. 1979; Brazo and Liston 1977; Consumers Power 1972; Liston and Tack 1973, 1974, 1975). The heaviest spawning occurs on the rocky areas around the jetties and breakwall during the third and fourth weeks of October (Brazo, pers. comm. 1979) or early November (Chiotti 1973).

MM-7

Stony Lake (43°34', 86°30')--Duck Lake (43°20', 86°24'). Several nearshore spawning areas have been identified in this region. From the 1940s to 1963 [see Authors' note, p. 95], lake trout spawned in an area (43°33', 86°31'--43°29', 86°29'), between Stony Lake and Flower Creek. From 1952 to 1963 [see Authors' note], lake trout spawned in an area (43°24', 86°27') about 1 1/2 mi N of White Lake over rock and in an area (43°24', 86°27'--43°18', 86°24'), extending from White Lake (43°23', 86°26') to about 2 mi S of Duck Lake Lake over rock and sand. Since 1952 [see Authors' note], spawning occurred in an area (43°28', 86°29'--43°24', 86°27'), extending from White Lake to Flower Creek (43°28', 86°28'), over sand (Organ et al. 1978).

Muskegon (43°13', 86°17'). Lake trout spawn in Lake Michigan at Muskegon, but spawning is not successful (FWS 1979d).

Mona Lake (43°10', 86°18')--Lake Macatawa (42°46', 86°13'). Commercial fishermen reported that spawning occurred throughout this area offshore at depths of about 250-350 ft. Native lake trout spawned until about 1946 in the northern portion (43°10', 86°35'--43°03', 86°35') of this area, between Mona Lake and Grand Haven (43°04', 86°13'), over a substrate of mud, clay, sand, and gravel. Spawning also occurred over mud and clay in the southern portion (43°03', 86°35'--42°46', 86°35') of the area (Organ et al. 1978). Plantings occurred at Port Sheldon (42°54', 86°13') in 1965, 1966, and 1968 (Rybicki and Keller 1978), and large numbers of ripe-running adults were collected in October and November 1977-78 in the vicinity of the Campbell Power Plant (42°55', 86°12') at Port Sheldon (Jude et al. 1978, 1979a; Jude, Heufelder, and Klinger, pers. comm. 1979). In late May 1980, 10 lake trout fry were captured south of the plant and north of the plant at the discharge and new intake structures at depths up to 50 ft (Jude, pers. comm. 1980).

The early literature reports no spawning grounds for native lake trout between Michigan City (41°44', 86°54') and St. Joseph (42°06, 86°29') (Milner 1874a). The major spawning areas were north of St. Joseph (Goode 1884). During the 1970s, planted lake trout spawned along the entire southeast shore of the lake over all bottom types in water less than 30 ft deep. This contrasts with the deeper water (60-240 ft or more) spawning of native trout which were present here prior to the 1940s (Tait 1973; Wells 1972). Lake trout were stocked at New Buffalo (41°48', 86°45') in 1967 (Rybicki and Keller 1978), and these stocked fish return inshore south of St. Joseph. In 1971, lake trout apparently spawned in large numbers in shallow water (generally less than 30 ft deep) over sand and boulders along the shoreline from the Indiana state line (41°46', 86°49') north to Holland (42°47', 86°07') (Wells 1972, Wells et al. 1971). All of these areas may also be nursery grounds (Wells 1972).

Saugatuck (42°40', 86°12'). In the late 1800s, "Honey Comb" Reef (42°39', 86°15'--42°36', 86°15'), about 2 mi S of Saugatuck, was a good lake trout spawning ground (Smith and Snell 1891). This reef has a substrate of rock and boulders and extends offshore to depths of about 72 ft (Wells 1972). In 1967-68, stocked fish spawned on Honey Comb reef (Organ et al. 1978). In 1971, ripe and spent females and males in spawning condition were collected off Saugatuck at 18-30 ft depths from mid- to late November (Wells et al. 1971). Since 1972, lake trout have spawned in an area (42°41', 86°13'--42°45', 86°13'), extending about 5 mi N from Saugatuck, over rock and gravel (Organ et al. 1978). In 1976, lake trout eggs were washed up on beaches in the Saugatuck area after a storm (Jude and Dorr, pers. comm. 1979).

Ganges (42°35', 86°13'). In 1967-68, planted lake trout spawned along shore in an area (42°34', 86°14'--42°37', 86°14') over gravel (Organ et al. 1978).

South Haven (42°24', 86°17'). Until 1948, native lake trout spawned in a large area (42°31', 86°24'--42°21', 86°27') about 10 mi offshore between South Haven and Glenn (42°31', 86°14') over a bottom of clay and mud at depths of about 130-200 ft (Organ et al. 1978). According to a commercial fisherman, native lake trout also spawned on clay banks (42°31', 86°28'--42°27', 86°28') in this same general area, about 15 mi offshore from Glenn, at a depth of about 240 ft (Owens, pers. comm. 1979). In 1971, ripe and spent females and males in spawning condition were collected off South Haven at 18 and 30 ft depths from mid- to late November (Wells et al. 1971).

Palisades Power Plant (42°19', 86°19'). Ripe and spent adults were collected near the plant in late October to early November 1972 (Consumers Power 1973a) and in late October 1973 (Consumers Power 1974). Large numbers of adults in spawning condition were also collected near the plant in early November 1978 (Wapora 1979c,d).

Lake Michigan Beach (42°13', 86°23'). Lake trout spawned here over a sand bottom at depths to 70 ft (Organ et al. 1978).

St. Joseph (42°06', 86°29'). Lake trout historically spawned here over clay (Stockwell 1875b). Spawning occurred in an area (42°09', 86°29') 2 mi N of St. Joseph over sand at depths of about 36 ft (Organ et al. 1978). In 1971, ripe and spent females and males in spawning condition were collected off St. Joseph in water 18 and 30 ft deep from mid- to late November (Wells et al. 1971).

Bridgman (41°56', 86°35'). During the 1930s-50s, native lake trout spawned in the area 12-15 mi offshore between Bridgman and Shoreham (42°03', 86°31') over mud at depths greater than 200 ft (Organ et al. 1978). During the 1970s, ripe adults of planted stocks moved inshore in October and November in the vicinity of the Cook Power Plant (41°59', 86°34') and also at Warren Dunes (41°54', 86°37') (Indiana and Mich. Power 1975; Jude 1977; Jude and Dorr, pers. comm. 1979; Jude et al. 1975, 1979b). The numbers of spent fish peaked in November (Jude et al. 1979b). Adults concentrate on riprap at the power plant and on a clay bank north of the plant (Jude and Dorr, pers. comm. 1979). Spawning evidently occurs somewhere in the area. In 1975, eggs were found windrowed on beaches in the area after a storm in November, and sculpins with lake trout eggs in their stomachs have been impinged at the plant (Jude and Dorr, pers. comm. 1979; Jude et al. 1979b).

Bridgman Reef (41°52', 86°42'). Since 1970, spawners have been caught on this reef over a rock substrate at a depth of about 30 ft (Organ et al. 1978).

New Buffalo (41°48', 86°45'). In the late 1940s, many ripe-running adults of both sexes were caught in an area (41°48', 87°09') 20 mi W of New Buffalo at a depth of about 100 ft over a bottom of shale rock and stones (Westerman, pers. comm. 1979).

SALMONID spp.

Indiana

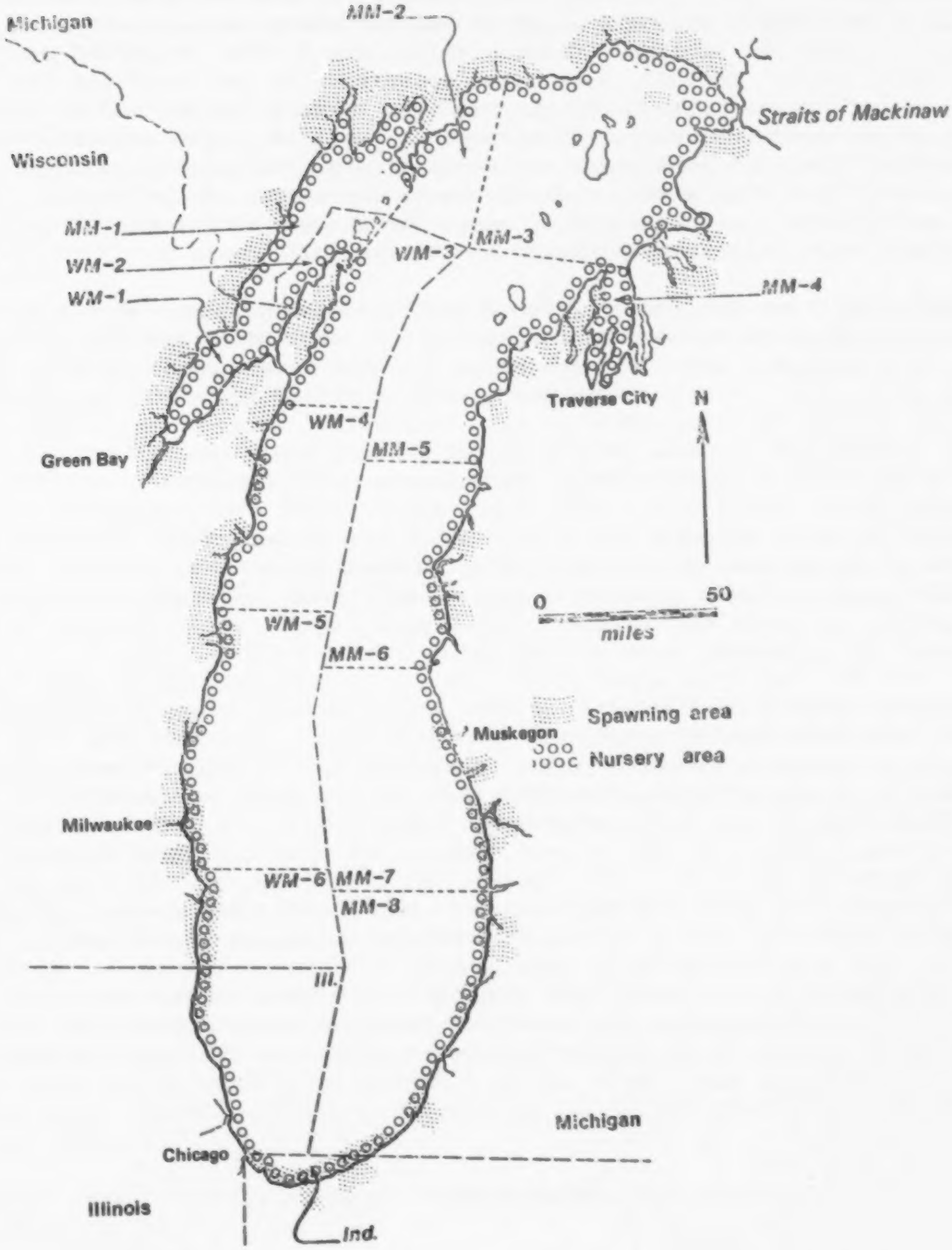
Bailly Generating Station (41°39', 87°07'). The eggs of an unidentified salmonid were entrained at the station during the last 2 weeks of December 1975 and the second week of November 1976 (Tex. Instrum. 1977b; 1976c).

Michigan

MM-7

Muskegon Lake (43°14', 86°18'). In 1974, a larva of an unidentified salmonid was entrained at the Cobb Power Plant (43°15', 86°15') in early March; salmonid eggs were entrained in early June (Consumers Power 1976f).

RAINBOW SMELT


Michigan
MM-2
Wisconsin
Straits of Mackinaw
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Rainbow smelt eggs planted in Crystal Lake, Michigan, in 1912 are believed to be the source of rainbow smelt found in all the Great Lakes except Lake Ontario (Van Oosten 1937a). Rainbow smelt made the first large spawning run from Crystal lake into Cold Creek in 1919 (Mich. Conserv. 1936). In 1923, rainbow smelt were first captured from Lake Michigan at Frankfort, near the mouth of the tributary that connects Crystal Lake and Lake Michigan (Creaser 1932; Dymond 1944; Wells and McLain 1972, 1973). By 1932, very large spawning runs had developed in streams along the north shore of Lake Michigan (Creaser 1932), and by 1936, rainbow smelt were dispersed throughout the lake (Wells and McLain 1972, 1973). Spawning runs enter tributary streams throughout the lake; spawning usually occurs within 1 mi of the stream mouth. Spawning also occurs in the lake in shallow gravel areas where there is current (Becker 1976; USBFC 1965; Walburg 1973; Wells and McLain 1973).

The largest populations of rainbow smelt and the greatest amount of reproduction occur in the northern areas of the lake (Wells and McLain 1973). All streams along the north shore probably have spawning runs (Leary, pers. comm. 1979). Green Bay is the center of rainbow smelt abundance in Lake Michigan (Hile et al. 1953; Wells, pers. comm. 1979). All the tributaries of Green Bay, especially those along the western shore, probably have spawning runs; spawning may also occur along shore (Belonger, pers. comm. 1979; Copes, pers. comm. 1979). Runs probably also occur in every Wisconsin tributary along the western shore of Lake Michigan proper (Copes, pers. comm. 1979; Kernen, pers. comm. 1979). Along the eastern shore, spawning occurs primarily on the beaches because there are few suitable tributaries (Owens, pers. comm. 1979). Stream runs along the southeast shore are sporadic (Warner 1979).

Rainbow smelt generally migrate from deeper water to inshore areas and then into tributary streams about the time of ice breakup. The abundance of adults peaks along shore during March and April at water temperatures of 40-50°F (CDM/Limnetics 1977; Copes, pers. comm. 1979; Euers 1960; Hile et al. 1953; Schneberger 1935; USDI 1966). The average length of the spawning period in Lake Michigan is about 2 weeks; spawning activity peaks in late April (Van Oosten 1953), although in 1979 spawning was still occurring in Little Bay de Noc in May (Copes, pers. comm. 1979). The time of hatching depends on the temperature and depth of the water where the eggs undergo embryonic development; hatching can occur as early as mid-May and as late as the first week in July (Owens, pers. comm. 1979). The nearshore waters of the entire lake are nursery areas for rainbow smelt larvae; older young-of-the-year (YOY) use the entire pelagic zone, especially the upper depth strata (Walburg 1973; Wells 1968, pers. comm. 1979).

Wisconsin

WM-1

Menominee River (45°06', 87°35'). The first reported run here occurred in March and April 1932 (Van Oosten 1937a; Wis. Dep. Agric. Mark.

1936); this tributary, which forms the boundary between Wisconsin and Michigan, still supports one of the largest runs in Green Bay (Belonger, pers. comm. 1979). The area from Marinette (45°05, 87°36') south to Peshtigo Reef (44°58', 87°36') appears to be a nursery area. Young-of-the-year are found here throughout the summer in 30 ft of water; densities are greater here than farther south in Green Bay (Belonger, pers. comm. 1979).

Oconto River (44°54', 87°50'). The first large spawning run here occurred in March 1934 under the ice; in 1935 the run was almost over by mid-April (Van Oosten 1937a; Wis. Dep. Agric. Mark. 1936). This tributary now supports one of the heaviest runs in Green Bay (Belonger, pers. comm. 1979). In 1978, many YOY were found in early September near Oconto Shoal (44°51', 87°47') in about 10 ft of water (Belonger 1979).

Pensaukee River (44°49', 87°54'). Prior to 1942, runs here occurred early in the spring while there was still ice cover; after 1942, the runs started later in April (Euers 1960; Wis. Dep. Agric. Mark. 1936). Runs also entered the river in the late 1950s (FWS 1979c).

Little Suamico River (44°42', 87°59'). In the early 1930s, runs ascended the river annually (Wis. Dep. Agric. Mark. 1936).

Big Suamico River (44°38', 88°00'). The first runs here occurred in 1933 (Van Oosten 1937a; Wis. Dep. Agric. Mark. 1936); these runs occurred under the ice until 1942; after 1942, the runs started later in the season (Euers 1960).

Fox River (44°32', 88°00'). In the early 1930s, runs ascended the river annually (Wis. Dep. Agric. Mark. 1936). Rainbow smelt still spawn at the head of Green Bay. In 1975-76, 98% of all the rainbow smelt impinged at the Pulliam Power Plant (44°32', 88°00') were taken in April during their inshore migration. Rainbow smelt eggs were entrained at the plant in April and May (NALCO, undated a); larvae were also entrained (CDM/Limnetics 1977).

Bay Settlement (44°33', 87°54'). Runs occurred in this area during the early 1930s (Wis. Dep. Agric. Mark. 1936).

Dyckesville (44°38', 87°46'). In 1933, the first runs of rainbow smelt were reported in several unnamed streams near Dyckesville (Van Oosten 1937a; Wis. Dep. Agric. Mark. 1936).

Red River (44°40', 87°45'). A spawning run occurs here (Poff and Threinen 1966a,b).

Sugar Creek (44°47', 87°40'). The first run here occurred in 1930 (Van Oosten 1937a).

Little Sturgeon Bay (44°50', 87°33'). In the 1930s, runs occurred in the small streams entering the bay (Van Oosten 1937a; Wis. Dep. Agric. Mark. 1936).

Sturgeon Bay (44°53', 87°24'). In 1932, runs occurred in Big and Little creeks (locations unknown) (Van Oosten 1937a).

WM-2

Egg Harbor (44°03', 87°17'). In the early 1930s, rainbow smelt spawned here (Wis. Dep. Agric. Mark. 1936).

Ephraim River (45°09', 87°10'). Rainbow smelt were present here in 1955 (FWS 1979c).

WM-3

Rainbow smelt may spawn along the shore from Four Foot Shoal (45°10', 87°00') to Baileys Harbor (45°03', 87°07') (Frederick, pers. comm. 1979).

Rowley Bay (45°13', 87°01'), North Bay (45°09', 87°04'), and Moonlight Bay (45°05', 87°05'). Rainbow smelt enter tributaries of these bays to spawn (Frederick, pers. comm. 1979).

Heins Creek (45°01', 87°09'). Spawning runs may enter the creek (Poff and Threinen 1965).

Hibbard Creek (44°59', 87°10'). The first run here was reported in 1930 (Van Oosten 1937a); runs also occurred here in the late 1950s (FWS 1979c) and in the 1960s (Poff and Threinen 1965).

South Creek (probably Whitefish Bay Creek, 44°55', 87°13'). The first run here was reported in 1930 (Van Oosten 1937a).

Shivering Sands Creek (44°52', 87°14'). Good fishing for rainbow smelt occurs here during the spawning runs (Poff and Threinen 1965).

Lilly Bay Creek (44°51', 87°16'). Good spawning runs occur here (Poff and Threinen 1965).

Woodard Creek (44°45', 87°20'). Rainbow smelt may spawn near the mouth of this creek (Poff and Threinen 1965).

Bear Creek (44°42', 87°21'). Spawning runs enter this river (Poff and Threinen 1965).

WM-4

Stony Creek (44°40', 87°23'). The first run here was reported in 1933 (Van Oosten 1937a; Wis. Dep. Agric. Mark. 1936); runs continued at least into the 1960s (Poff and Threinen 1965, 1966b).

Ahnapee River (44°36', 87°26'). A spawning run enters the river (Poff and Threinen 1966a,b). Runs were first reported at Algoma in the early 1930s (Wis. Dep. Agric. Mark. 1936).

Kewaunee River (44°28', 87°30'). In the early 1930s, spawning runs ascended the river annually (Wis. Dep. Agric. Mark. 1936); a run still occurs here (Poff and Threinen 1966a,b).

Kewaunee Power Plant (44°21', 87°32'). Rainbow smelt spawn along much of the shore zone near the plant (LaJeone 1976b; USAEC 1972e). An influx of ripe-running adults has been observed mainly in late April when water temperatures reach 46-49°F (Ind. Bio-Test 1972; LaJeone, pers. comm. 1979; NALCO 1976b, undated b). Spent adults were found near the plant in late May (NALCO 1976b). Eggs were also found in the area and were entrained at the plant in April and May; peak abundance occurred in late April (LaJeone 1976; NALCO, undated b). Larvae entrained from April to July were mostly rainbow smelt (NALCO, undated b); YOY were present here in the inshore waters in the fall (Ind. Bio-Test 1972).

Point Beach Power Plant (44°17', 87°32'). Rainbow smelt apparently spawn in many areas along the shoreline here and exhibit little preference for substrate (Wis. Elec. Power 1975a). Ripe adults enter the inshore zone in large numbers in March and April; many fish are attracted to the discharge area of the plant (Limnetics 1974; Reed 1972; Romberg and Spigarelli 1973; Wis. Elec. Power, undated, 1975a, 1976c; Wis. Elec. Power and Wis.-Mich. Power, undated a,b). Catches in the area decline rapidly in May coinciding with the end of spawning (Limnetics 1974; Wis. Elec. Power and Wis.-Mich. Power, undated a), and the adults leave the area by June and July, when alewives appear (Romberg and Spigarelli 1973; Wis. Elec. Power and Wis.-Mich. Power, undated b). Many rainbow smelt eggs are found in the area near the plant from March to June, when large number of adults are present (Limnetics 1974; Wis. Elec. Power, undated, 1975a; Wis. Elec. Power and Wis.-Mich. Power, undated a,b,c). Larvae, fry, and YOY were collected in the area from May to September (Limnetics 1974; Wis. Elec. Power, undated, 1975a, 1976c; Wis. Elec. Power and Wis.-Mich. Power, undated a,b,c).

Molash Creek (44°11', 87°31'). A spawning run occurs here (Weber, Desparte, and Threinen 1968).

Two Rivers (44°09', 87°34'). Annual spawning runs were first reported in the early 1930s (Wis. Dep. Agric. Mark. 1936).

Manitowoc River (44°05', 87°39'). In the early 1930s, rainbow smelt ascended the river annually (Wis. Dep. Agric. Mark. 1936).

Silver Creek (44°04', 87°39') and Calvin Creek (44°02', 87°40'). Spawning runs occur here (Weber, Desparte, and Threinen 1968).

Pine Creek (43°59', 87°42'). A spawning run occurs here during favorable years (Weber, Desparte, and Threinen 1968).

Point Creek (43°58', 87°42') and Fischer Creek (43°56', 87°43'). Spawning runs occur here (Weber, Desparte, and Threinen 1968).

Haven (43°51', 87°44'). Ripe-running adults were collected here in April and May (Ind. Bio-Test 1977; LaJeone, pers. comm. 1979). Larvae and fry were collected from April to September and were most abundant from May to August in 5-20 ft of water (Ind. Bio-Test 1977; Wis. Elec. Power, unpubl. data; Wis. Elec. Power et al. 1979a,b). A run enters Sevenmile Creek (43°51', 87°44') (Weber, Poff, and Threinen 1968).

Sheboygan (43°45', 87°42'). Spring runs of rainbow smelt occur in the Pigeon River (43°47', 87°43') (Weber, Poff, and Threinen 1968), the Sheboygan River (43°45', 87°42') (USDI 1966), and the Black River (43°42' 87°42') (Weber, Poff, and Threinen 1968). In 1975-76, ripe or ripening adults were impinged at the Edgewater Power Plant (43°43', 87°42') from late March to mid-April. A few larvae were entrained from April to September (Swanson Environ. 1976). In 1977-78, early postlarvae were collected nearshore from May to mid-October; YOY were abundant in the nearshore waters in September (Swanson Environ. 1979).

Port Washington (43°23', 87°52'). The first run was reported in Sauk Creek (43°23', 87°52') in 1933 (Van Oosten 1937a). Spawning runs occur throughout Ozaukee County (43°33', 87°48'--43°12', 87°54') (Poff et al. 1964). Large numbers of fish spawn at Port Washington (Binkowski, pers. comm. 1979). Spawning adults were collected at the Jones Island Waste Water Treatment Plant (43°23', 87°52') (Binkowski, pers. comm. 1979); fishermen frequently catch rainbow smelt here in April over a sandy bottom (Janssen, pers. comm. 1979). In 1975, ripe adults were impinged at the Port Washington Power Plant (43°23', 87°52') from late March to late May; peak impingement occurs in April and May (Wis. Elec. Power 1976e). Eggs were entrained in May; larvae were entrained from mid-July through September (Norden, pers. comm. 1979; Wis. Elec. Power 1976e). Larvae were collected in the lake from May through August (Wis. Elec. Power, unpubl. data, 1976e).

Milwaukee (43°02', 87°54'). Rainbow smelt spawn very close to shore in the Milwaukee area. The inshore movement usually occurs in April, but the timing of the run is dependent upon water temperature (Binkowski, pers. comm. 1979; Schaefer 1955). Ripe-running males and females are collected in Whitefish Bay (43°08', 87°53') and Milwaukee Harbor (43°02', 87°53') (Janssen, pers. comm. 1979). Runs enter the unnammed creek (43°12', 87°54') north of Fox Point (43°10', 87°53') (Norden, pers. comm. 1979) and the Milwaukee River (43°02', 87°54') (Poff and Threinen 1964). Spawning occurs at Doctor's Park on Fox Point, at North Point (43°04', 87°52'), and at Bradford (43°04', 87°52') and McKinley (43°03', 87°53') beaches (Binkowski, pers. comm. 1979; Norden, pers. comm. 1979). Larvae are caught in Milwaukee Harbor (Janssen, pers. comm. 1979; Norden, pers. comm. 1979); YOY are present off McKinley Beach during the summer, when inshore water temperatures are between 45-52°F (Binkowski, pers. comm. 1979). In 1973, eggs were found in May at the Lakeside Power Plant (42°58', 87°51') 4 mi S of Milwaukee Harbor; YOY were also collected there (Limnetics 1974; Wis. Elec. Power 1975c).

Oak Creek (42°54', 87°51'). Adults enter the creek to spawn (Norden, pers. comm. 1979).

Oak Creek Harbor (42°51', 87°50'). Spawning appears to occur along the entire shoreline here (Wis. Elec. Power 1975b). Ripe males and females were impinged at the Oak Creek Power Plant (42°51', 87°50') beginning in late March (Limnetics 1974; Wis. Elec. Power 1976d). Eggs were found in April to June, and larvae, fry, and YOY were present from April to October (Ball 1971; Limnetics 1974; Wis. Elec. Power 1975b, 1976d). Large numbers of eggs were collected at the plant intake in April; the plant's intake channel is reported to be a favored spawning area. Adults leave the nearshore zone by early summer (Limnetics 1974).

WM-6

Kenosha (42°40', 87°48'--42°29', 87°48') and Racine (42°49', 87°49'--42°40', 87°48') Counties. Rainbow smelt enter shallow water and streams in the area to spawn (Poff and Threinen 1961a,b).

Illinois

Spawning may occur along the entire Illinois shoreline (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). The shoreline area from just north of the Wisconsin stateline (42°29', 87°48') and south to Waukegan is a spawning and nursery area (Cochran, undated; Cochran and Cima 1974; Commonw. Edison 1976; Ind. Bio-Test 1975b; LaJeone, pers. comm. 1979). Seine catches and impingement of ripe and spawning adults at the Waukegan (42°23', 87°49') and Zion (42°27', 87°48') Generating Stations increase during the inshore run in March and April, at a water temperature of about 37°F (CDM/Limnetics 1976c; Cima 1977; Cochran and Kitchell 1976; Kitchell and Otto 1974; Muench 1974; Orpret and Cochran 1976; Otto 1975). Spawning begins at water temperatures of about 41-43°F and peaks during the last 2 weeks of April and ends in May (CDM/Limnetics 1976c; Cima et al. 1974; Cochran, undated; Cochran and Cima 1974). A post-spawning migration to offshore waters occurs in May and June (Otto 1975). Spawning appears to be restricted to the beach zones and does not occur in any of the small streams in the area (Otto 1975). Spawning fish seem to be attracted to the discharge current of the Zion Generating Station, where maximum spawning activity occurs in water about 22 ft deep (Cima et al. 1976; Muench 1974; Otto 1975). Eggs were found throughout the entire Zion-Waukegan area in April and May when water temperatures were about 43-50°F; most eggs were collected in the beach zone at depths of less than 30 ft (CDM/Limnetics 1976c; Cima 1977; Cima et al. 1976; Cochran, undated; Cochran and Cima 1974; Muench, pers. comm. 1979; Otto 1975). Larval abundance peaks in late June; YOY have been collected throughout the summer, mainly at depths of 30 ft or less (CDM/Limnetics 1976c; Cima 1977; Cima and Cochran, undated; Cima et al. 1976; Cochran, undated; Cochran and Cima 1974; Ind. Bio-Test 1975b; LaJeone, pers. comm. 1979; Otto 1975).

Indiana

Rainbow smelt spawn along the entire shoreline and in tributaries; peak spawning activity usually occurs in mid-April (Koch, pers. comm. 1979). Ripe adults were caught by fishermen everywhere along the shore as early as late March (Westerman, pers. comm. 1979). Almost the entire Indiana beach zone is a nursery area (McComish, pers. comm. 1979).

Hammond (41°40', 87°30'). In 1975-76, impingement of adults at the Stateline Generating Station (41°42', 87°31') peaked during the spawning period. Rainbow smelt are believed to spawn successfully in the area. Eggs were present during April and May. Larvae were collected from May to August, most were taken from late May to late June (NALCO 1976c).

Joerse Park (41°39', 87°26'). Rainbow smelt are caught here during spawning runs (Palacios, pers. comm. 1979).

Gary (41°37', 87°20'). Rainbow smelt spawn successfully in the vicinity of the Mitchell Power Station (41°37', 87°22') (NALCO 1976a). Adults are netted by sport fishermen during the spawning run in late April (NALCO 1976a). Eggs are present in May; larvae are present from May to September (Krueger 1976; NALCO 1976a).

Bailly Generating Station (41°39', 87°07'). Spawning runs enter tributaries near the station, including Burns Ditch (41°38', 87°10'), Little Calumet River (41°37', 87°10'), and Dunes Creek (41°39', 87°05') (Tex. Instrum. 1975b, 1976a). Spawning also may occur here along the lake shore (Tex. Instrum. 1976a). Spawning usually begins in early April and peaks in May, and impingement of adults at the plant is highest at this time (Tex. Instrum. 1976c). Eggs and larvae were collected in the area and were entrained at the station from March to July; peak abundance occurred in May (Tex. Instrum. 1975b, 1976c, 1977b). Young-of-the-year were captured with seines along shore in August (Tex. Instrum. 1979a).

Michigan City (41°43', 86°54'). Spawning runs occur at the dunes area (41°42, 86°57') west of Michigan City (Palacios, pers. comm. 1979). Runs also occur at the Michigan City Pier (Koch, pers. comm. 1979), at the Yacht Basin (41°43', 86°54') (Palacios, pers. comm. 1979), and in Trail Creek (41°44', 86°54') from April to early May (McComish, pers. comm. 1979). At the Michigan City Generating Station (41°43', 86°54') on Trail Creek, large numbers of ripe adults are impinged from March to May (Morgan 1978a). Most adults move offshore in June or July (McComish, pers. comm. 1979; Morgan 1978a). A few larvae are entrained at the station (Morgan 1978a), and many YOY are found in the nearshore zone from July to September (Koch, pers. comm. 1979; McComish, pers. comm. 1979; Willis 1975).

Michigan

MM-1

Turtle Creek (45°09', 87°36'). In 1932, a small run occurred in March and April (Van Oosten 1937a).

Springer Creek (45°11', 87°34'). The first run here occurred on March 27-28, 1930 (Van Oosten 1937a).

Beattie Creek (45°14', 87°31'). In 1932, a small run occurred in March and April (Van Oosten 1937a).

Cedar River (45°24', 87°21'). The first run here was reported in March to April 1932 (Van Oosten 1937a); a run also occurred in 1955 (FWS 1979c).

Bark River (45°34', 87°14'). Many adults were present in the river in 1955 (FWS 1979c). In 1978, many eggs were found north of the river mouth in early May. Larvae were present from May through August near the river mouth; peak abundance occurred from mid-May to mid-June (Wis. Elec. Power, unpubl. data).

Ford River (45°40', 87°08'). A spawning run occurs here (Warner 1979). In 1978, eggs were collected off the river mouth in May; larval abundance peaked there in late May, and larvae were present in the area until late August (Wis. Elec. Power, unpubl. data).

Little Bay de Noc (45°45', 87°00'). Adults are very common in the bay during April and May (Peck 1974; Wagner 1972, 1973). During 1960-65, ripe adults were collected as they entered the Rapid River (45°55', 86°58') from late April to early May (Norden, pers. comm. 1979). In 1932, a run occurred in the Days River (45°54', 86°59') (Van Oosten 1937a), and in 1954 and 1955, adults were found in the Days, Tacoosh (45°55', 86°58'), and Whitefish (45°55', 86°57') rivers and Squaw Creek (45°48', 86°59') (FWS 1979c). In 1968, a run occurred in the Whitefish River (Jenkins 1968).

Big Bay de Noc (45°45', 86°45'). In 1931 and 1932, extensive runs occurred in all tributaries of Delta County, which surrounds both Big and Little Bay de Noc (45°45', 87°00'). These streams included the Ogontz (45°52', 86°46'), Sturgeon (45°50', 86°40'), and Fishdam (45°54', 86°35') rivers (Mich. Conserv. 1932c; Van Oosten 1937a). In 1954 and 1955, rainbow smelt were found in the Sturgeon and Fishdam rivers (FWS 1979c). In 1979, good runs occurred in tributaries near Garden (45°46', 86°33') during the last week in April (Ann Arbor News 1979b).

MM-2

Southtown Creek (45°56', 86°16'). A small run occurred in April 1944 (Van Oosten 1944b).

Crow River (46°02', 85°36'). A run occurred in April 1936 (Van Oosten 1937a).

Rock River (46°05', 85°32'). A run occurred in the spring of 1936 (Van Oosten 1937a), and in 1976 (FWS 1979c).

Black River (46°06', 80°21'). A run occurred in the spring of 1936 (Van Oosten 1937a), in the late 1950s (Stauffer 1972), and in 1979 (Warner 1979).

Mille Coquins River (46°06', 85°29'). A run occurred in the spring of 1936 (Van Oosten 1937a).

Paquin Creek (46°04', 85°13') and Davenport Creek (46°04', 85°16'). Runs occurred in the spring of 1936 (Van Oosten 1937a).

Cut River (46°03', 85°07'). A run occurred in April 1932 (Van Oosten 1937a).

White Shoal (45°50', 85°09'). In 1972, spawning occurred on the shoal in April and May, over sand, rock, and mud to depths of 40 ft (Organ et al. 1978).

Brevoort River (45°57', 84°56'). A run occurred in 1979 (Warner 1979).

Carp Lake River (45°45', 84°50'). The first run here was reported in 1931 (Van Oosten 1937a).

Big Sucker Creek (45°44', 84°56') and Little Sucker Creek (45°44', 84°57'). The first runs here were reported in April 1936 (Van Oosten 1937a).

Bear River (45°23', 84°58'). A run was first reported here in early April 1931 (Van Oosten 1937a).

Big Rock Point (45°22', 85°12'). In 1974-75, adults were impinged at the Big Rock Power Plant (45°22', 85°12') in mid-April and May. Eggs were collected in April and May and were most abundant in late May. Larvae were collected from late May to mid-September (Consumers Power 1976e).

Lake Charlevoix (45°17', 85°10'). In 1929, spawning runs developed in several tributaries to Lake Charlevoix (Creaser 1932). The following creeks and rivers developed spawning runs by 1930 (Creaser 1930).

> Boyne River (45°13', 85°01'). In 1930, a run moved upstream to the dam from March to late April, when temperatures were often just above freezing; runs were heaviest in mid-March when the water temperature was about 37°F.

Porter Creek (45°13', 85°04'). In 1929, a run moved about 750 ft upstream to the dam; the run began in mid- to late March, when the water temperature was about 33°F.

Jordan River (45°09', 85°08'). In 1930, a small run moved upstream to the dam on Deer Creek (45°08', 85°07'); the run began on March 21 when the water temperature was about 35°F.

Brown Creek (45°10', 85°08'). In 1930, a run occurred on March 21.

Horton Creek (45°17', 85°05'). In 1930, a run moved 1/4 mi upstream to the dam on March 20.

Stover (Strover) Creek (45°18', 85°15'). In 1929, a run entered the creek in late March.

MM-4

Grand Traverse Bay (45°05', 85°30'). In 1972, rainbow smelt were more abundant in the bay than in any other area of Lake Michigan. Runs enter many small tributaries to the bay in late March-April; dams limit reproduction in these streams (Bower 1954; Price and Kelly 1976).

Leo Creek (44°58', 85°39'), Belangers Creek (45°01', 85°37'), Weaver Creek (45°02', 85°36'), and Deuster Creek (location unknown). Spawning runs were first reported here in 1935 (Van Oosten 1937a).

Northport Bay (45°07', 85°35'). The first run was reported here on April 10, 1953; the run lasted only 3 hours. Spawning occurred along the shores of the bay, near the village of Northport. Eggs were found attached to stones in about 3 ft of water (Lievense 1954).

MM-5

Platte River (44°44', 86°09'), Otter Creek (44°46', 86°04'), Shalda Creek (44°57', 85°53'), and Leland Harbor (45°01', 85°46'). Spawning runs occurred in 1979 (Warner 1979).

MM-6

Gurney Creek (44°08', 86°25') and Connor Creek (44°07', 86°26'). Small runs occur here (Brazo, pers. comm. 1979).

Ludington (43°57', 86°28'). Spawning occurs in the area from Ludington south to approximately Bass Lake (43°50', 86°26'), and peak spawning occurs sometime between mid-April and early May (Brazo, pers. comm. 1979). Spawning occurs primarily along shore; there are no heavy runs into creeks in the area (Brazo, pers. comm. 1979), although rainbow smelt are abundant in Pere Marquette Lake (43°56', 86°26') during the spring (FWS 1979d). Spawning adults have been collected throughout the area (Brazo, pers. comm. 1979); the largest numbers of adults are present at the Ludington Pumped Storage Plant (43°54', 86°27') during the spawning runs (Brazo and Liston 1977; Liston and Tack 1975). Large numbers of larvae are collected at the plant beginning in mid- or late May (Brazo, pers. comm. 1979; Liston et al. 1978). Young-of-the-year are collected near the plant (Brazo, pers. comm. 1979; Liston and Tack 1974); in 1979, YOY were found in large numbers throughout the summer between the 5 and 40 ft depth contours (Brazo, pers. comm. 1979).

Bass Lake outlet (43°50', 86°26'). A small spawning run occurs here (Brazo, pers. comm. 1979).

MM-7

Muskegon (43°13', 86°17'). During 1932-70, spawning occurred over sandy substrate at depths less than 30 ft in an area extending from Mona Lake (43°10', 86°18') to White Lake (43°23', 86°26') (Organ et al. 1978). Rainbow smelt are also abundant in Muskegon Lake (43°14', 86°18') in the spring. In 1974-75, most adults were impinged at the Cobb Power Plant (43°15', 86°15') on Muskegon Lake from late April to mid-May (Consumers Power 1976f; FWS 1979d).

Grand Haven (43°04', 86°13'). Larvae were collected off Grand Haven, primarily in late June to late July (Brandt 1978; Wells 1973).

Little Pigeon (Pine) Creek (42°58', 86°13'). A spawning run occurs here (Tin and Heufelder, pers. comm. 1979).

Port Sheldon (42°54', 86°13'). Adults spawn in shallow areas here and then return to deeper water (Jude et al. 1978, 1979a). Many ripe-running adults were collected in the sandy beach zone during late April and early May (Jude 1978; Jude et al. 1978, 1979a; Tin and Heufelder, pers. comm. 1979). In 1978, peak spawning occurred near the Campbell Power Plant (42°55', 86°12') in late April and early May; limited spawning extended into early June (Jude et al. 1979a). Spawning runs may also enter Pigeon Lake (42°54', 86°12'), from which the plant withdraws water. About 75% of the impingement at the plant occurred in April and May during the spawning season (Consumers Power 1976b; Jude 1978). Eggs were entrained at the plant in late April (Consumers Power 1976b). Entrainment of larvae peaked in late May and continued into September. In 1978, entrainment of larvae declined in early June after peak hatching had occurred and larvae began to move offshore (Jude 1978; Jude et al. 1979a; Wapora 1979a). Newly hatched larvae were found in Lake Michigan in water about 10 ft deep in mid-May and at depths to about 50 ft during late June and early July (Jude et al. 1978, 1979a; Tin and Heufelder, pers. comm. 1979). In 1979, huge schools of larvae were observed in August in 10-18 ft of water along the jetties where Pigeon Lake enters Lake Michigan (Tin and Heufelder, pers. comm. 1979; Wapora 1979a). Young-of-the-year are caught with seines and trawls during July to November; the largest trawl catches are made at water depths of 10-60 ft (Jude et al. 1978, 1979a).

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Rainbow smelt larvae are generally common or abundant all along shore from the beach zone out to depths of about 240 ft from early May to mid-August (Harris and Eschmeyer 1975; Owens, pers. comm. 1979).

Halfway Creek (42°43', 86°12'). Rainbow smelt spawn over gravel at the mouth of the creek (Owens, pers comm. 1979).

Saugatuck (42°40', 86°12'). In 1979, spawning was observed in approximately 3 ft of water at Oval Beach (42°40', 86°13') south of Saugatuck from April 25 to May 10, and rainbow smelt eggs were collected here on artificial substrates (Owens, pers. comm. 1979). In 1980, adults in spawning condition were captured on the reef (42°38', 86°17') near Saugatuck from shore out to a depth of about 60 ft during late April and early May (Owens, pers. comm. 1980). According to fishermen, spawning runs entered the Kalamazoo River (42°40', 86°13') and smaller tributaries in the area; runs have not been observed here recently (Owens, pers. comm. 1979).

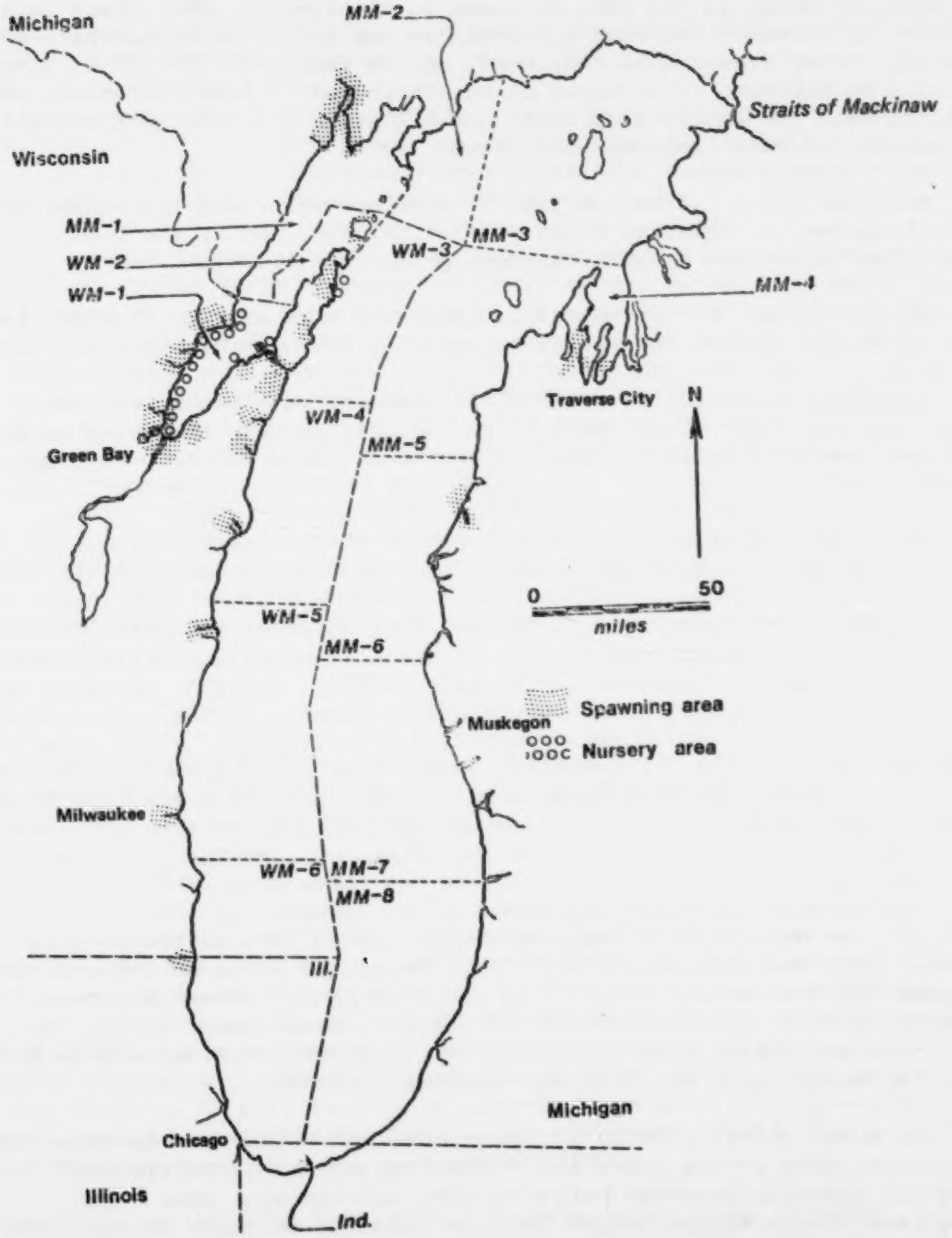
Cove Creek (42°35', 86°14'). Rainbow smelt spawn over gravel that extends along shore approximately 1 mi on each side of the creek mouth; a spawning run also probably enters the creek. Spawning occurs here from the end of April to about May 10 (Owens, pers. comm. 1979).

Palisades Power Plant (42°19', 86°19'). Rainbow smelt spawn in this area (Consumers Power 1972b; Patriarche 1972). Spawning was observed along the shoreline from late April to mid-May (Wapora 1979c,d). Many adults were impinged at the plant in April and May during the spawning run (Consumers Power 1975); adults disperse offshore after spawning (Wapora 1979d). Many eggs were collected in the area, as early as March; highest densities occurred along the shoreline (Consumers Power 1973b, 1976g; Wapora 1979c). Rainbow smelt larvae were collected from April to October; maximum abundance occurred in mid- to late May. Many small prolarvae were collected; postlarvae were reported to disperse offshore to depths of 27-30 ft or more and then to move back inshore as juveniles, just over 1 in. long (Wapora 1979c). Numerous fry and YOY were collected throughout the area (Consumers Power 1974, 1975; Patriarche 1973a,b, 1974; Wapora 1979d; Wells 1973, 1974). In 1973, many fry were found in late August, which indicated that spawning had been delayed or that the spawning period had been extended. Young-of-the-year were impinged at the power plant in September and October (Consumers Power 1974).

Bridgman (41°56', 86°35'). Spawning runs occur throughout the area from the Cook Power Plant (41°59', 86°34') to the Warren Dunes (41°54', 86°37') principally in April and May (Indiana and Mich. Power 1975; Jude, pers. comm. 1979; Jude et al. 1975, 1979b). Most spawning occurs in the beach zone and at the mouths of the creeks at Warren Dunes and at Weco Beach (41°56', 86°35') (Jude 1976a, pers. comm. 1979; Jude et al. 1975, 1979b) from mid-April to early May when the water temperature reaches approximately 43-50°F (Indiana and Mich. Power 1975; Jude 1976a; Jude et al. 1975, 1979b); adults move to deeper water by late May (Indiana and

Mich. Power 1975). Eggs were found in the area, almost exclusively in the beach zone; eggs were also entrained at the Cook Power Plant (CDM/Limnetics 1977; Indiana and Mich. Power 1975). Larvae and YOY are abundant in the area through October (Jude et al. 1973, 1975, 1979b; Jude, pers. comm. 1979; Wells 1973, 1974). The entire area from the beach zone out to a depth of 30 ft is a nursery area for rainbow smelt (Jude, pers. comm. 1979; Jude et al. 1979b).

NORTHERN PIKE


Michigan
MM-2
Wisconsin
Straits of Mackinaw
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Wisconsin

WM-1

The west shore of Green Bay (45°05', 87°25') has a substantial population of northern pike; these fish migrate up virtually every stream and drainage ditch in the area to spawn in the spring. When there is an increase in stream flow, runs may begin at the end of March before ice breakup. After spawning is completed, adults return to the lake. There may also be resident populations of adults in the streams (Belonger, pers. comm. 1979). The entire west shore and all areas with emergent vegetation are nursery grounds (Kernen, pers. comm. 1979).

Peshtigo River (44°58', 87°39'). Ripe northern pike are caught by sport fishermen at Peshtigo Point (44°59', 87°38') and in the Peshtigo River just before ice breakup (Ebener, pers. comm. 1979).

Thomas Slough (44°57', 87°49'). Northern pike migrate from the lake into the slough during the spring to spawn (Carlson et al. 1977).

Pensaukee River (44°49', 87°54'). Spawning runs enter the river. These runs may occur under the ice, and usually precede the white sucker runs that begin in April (Horrall, pers. comm. 1979; Imhof, pers. comm. 1979).

Little Suamico River (44°42', 87°59'). A spawning run occurs in the river prior to the sucker run in April (Horrall, pers. comm. 1979).

Peaks Lake (44°34', 88°02')--Little Tail Point (44°40', 87°59'). Before 1920, this marsh area was one of the most heavily utilized spawning grounds in Green Bay (Coberly and Horrall 1980b). In 1975, northern pike were observed on several spawning grounds in flooded fields, weed choked ditches and marshy areas between Long Tail Point (44°35', 87°59') and Duck Creek (44°34', 88°02'). A few males appeared on April 4 when an inch of ice still covered the ditches; more adults were present a few days later. Spawning was underway on April 11; water temperatures at this time ranged from 35°F in the morning to 54°F in the afternoon. By April 15 most of the fish had spawned and returned to the bay (Langhurst 1975a). In 1976, ripe females were collected and spawning was observed in this area on March 27; two days of 60°F temperatures and heavy rain initiated pike movement into the ditches (WDNR 1976). The marshy edges of the west shore of Green Bay are nursery grounds for northern pike. Larvae may remain for weeks in streams before migrating out (Kernen, pers. comm. 1979). In 1975, yolk-sac larvae approximately 1 in. long were observed and collected in the spawning areas in early May (Langhurst 1975b).

Fox River (44°32', 88°00'). During the mid-1920s, the spawning run of northern pike in the river was stopped by the dam at DePere (44°27', 88°04'). Spawning occurred below the dam, and the eggs were swept downstream (Izaak Walton League 1925, as cited in Bertrand et al. 1976). Northern pike presently move into the river to spawn (FWS 1979d). In 1975, eggs believed to be those of northern pike were entrained at the

Pulliam Power Plant (44°32', 88°00') at Green Bay (44°30', 88°00') during April and May; the water entering the plant is pumped from both Green Bay (45°05', 87°25') and the Fox River (NALCO undated a).

Red River (44°40', 87°45'). A spawning run enters the river in the spring (Poff and Threinen 1965, 1966a,b).

Sugar Creek (44°47', 87°40'). A spawning run enters the creek in the spring (Poff and Threinen 1965).

Little Sturgeon Bay (44°50', 87°33'). Spawning runs enter Keyes Creek (44°49', 87°33') and two other unnamed tributaries in the spring (Poff and Threinen 1965). The marshy shorelines with emergent vegetation are nursery areas (Kernen, pers. comm. 1979).

Sturgeon Bay (44°53', 87°24'). In 1972, northern pike were observed migrating into Sawyer Creek in Sawyer Harbor (44°53', 87°26') on April 16. The run entered the creek under the ice and progressed 1 mi upstream. A ripe female was collected on April 20 in Sawyer Creek. On April 24 most of the northern pike collected in the harbor were ripe; two spent females were also taken. Spawning probably occurred from April 16 through April 30 and may have occurred earlier in the creek than in the harbor. Spawning probably occurs in the marsh areas of the harbor after the ice cover breaks up. During years of low runoff when the creek is impassable, spawning probably takes place only in the marshy shorelines of the harbor (Kernen 1972). Successful spawning also occurs in the Sturgeon Bay Ship Canal (44°48', 87°19') (FWS 1979d). In Sturgeon Bay, any area with emergent vegetation is a nursery ground for northern pike. Fry about 1 in. long were present in Sawyer Creek during June (Kernen, pers. comm. 1979).

WM-2

Washington Island (45°23', 86°54'). Northern pike spawn in Detroit (45°21', 86°55'), West (45°22', 86°57') and Jackson (45°24', 86°51') harbors (Coberly and Horrall 1980b).

WM-3

Mink River (45°14', 87°02'). A spawning run enters the river immediately after ice out, which usually occurs in late March or early April; this run precedes the white sucker runs, which occur in April (Daly 1974; Frederick, pers. comm. 1979; Poff and Threinen 1965). In 1974, ripe males and females were collected in the river from April 13-20, and the first spent females were collected on April 20 (WDNR 1974a). The head of Rowley Bay (45°13', 87°01') is also an important northern pike spawning area (Coberly and Horrall 1980b). The marshes of Rowley Bay are nursery areas for northern pike (Kernen, pers. comm. 1979).

Three Springs Creek (45°09', 87°04') and Reiboldt Creek (45°06', 87°05'). Spawning runs enter these creeks immediately after ice out, which usually occurs in late March or early April; the runs precede the white sucker runs, which occur in April (Frederick, pers. comm. 1979; Poff and Threinen 1965). The marshes of North Bay (45°09', 87°04') and Moonlight Bay (45°05', 87°05') are nursery areas for northern pike (Kernen, pers. comm. 1979).

Heins Creek (45°01', 87°09'). This creek may support a run (Poff and Threinen 1965).

Hibbard Creek (44°59', 87°10'), Whitefish Bay Creek (44°55', 87°13'), and Bear Creek (44°42', 87°21'). Spawning runs occur here (Poff and Threinen 1965).

WM-4

Stony Creek (44°40', 87°23'). A spawning run enters the lower 4-6 mi of the creek in the spring (Poff and Threinen 1965).

Ahnapee River (44°36', 87°26') and Kewaunee River (44°28', 87°30'). Significant runs enter these rivers in early spring, possibly under the ice; these runs precede the white sucker runs (Horrall, pers. comm. 1979; Imhof, pers. comm. 1979; Poff and Threinen 1966).

East Twin River (44°09', 87°34'). Spawning runs enter the river. After spawning, many northern pike move out of the river and into the area around Two Rivers Harbor (44°09', 87°34') (Hanson, pers. comm. 1979).

West Twin River (44°09', 87°34'). Runs enter the river early in the spring, probably under the ice; the runs precede the white sucker run (Imhof, pers. comm. 1979). After spawning, many northern pike move out of the river and into the area around Two Rivers Harbor (44°09', 87°34') (Hanson, pers. comm. 1979).

WM-5

Pigeon River (43°47', 87°43'). Spawning runs enter the river in favorable years (Weber, Desparte, and Threinen 1968).

Milwaukee River (43°02', 87°54'). Northern pike are common in the river in the spring during the spawning run (Poff and Threinen 1964).

Illinois

Dead River (42°24', 87°48'). Northern pike enter the river and spawn in marshy areas (Muench, pers. comm. 1979).

Michigan

MM-1

Little Bay de Noc (45°45', 87°00'). Northern pike spawn in the marshy areas and small marshy tributaries of Little Bay de Noc (Copes and

Ebener, pers. comm. 1979; FWS 1979d). Spawning occurs successfully in the large wetland in the vicinity of Portage Point (45°42', 87°04') (FWS 1979d). During 1959-62, eggs were collected from ripe northern pike in the bay (Cook 1961, 1962).

MM-4

Grand Traverse Bay (45°05', 85°30'). The few wetlands of this bay are extremely important spawning areas (FWS 1979d). Specific spawning grounds were not identified, but the wetlands are generally located at the heads of the east and west arms of the bay and near Lee Point (44°56', 85°36').

MM-6

Manistee (44°15', 86°20'). Since the 1930s, northern pike have spawned along the shoreline between Manistee and Bar Lake (44°18', 86°18') over rock (Organ et al. 1978). Northern pike from Manistee Lake (44°15', 86°18') spawn heavily in the sloughs and the floodplain of the lower Little Manistee River (44°13', 86°16') (Wicklund and Dean 1957).

Ludington Pumped Storage Plant (43°54', 86°27'). A few adults in spawning condition are caught onshore and around the jetties here from late March to the third week of April. These fish are probably migrating through the area, enroute to riverine spawning grounds (Brazo, pers. comm. 1979).

MM-7

Port Sheldon (42°54', 86°13'). Examination of the gonads of fish taken in the area indicates that most spawning probably occurs in March and that spawning is completed by May (Jude et al. 1979a); no specific spawning areas were identified.

MUSKELLUNGE

Wisconsin

WM-1

Peaks Lake (44°34', 88°02'). Muskellunge spawn in the marshes here. Before 1920, this area, north to Little Tail Point (44°40', 87°59'), was one of the most heavily utilized spawning areas in Green Bay (Coberly and Horrall 1980b).

Sturgeon Bay (44°53', 87°24'). Historically, muskellunge spawned in the marshes here. Young-of-the-year muskellunge have recently been stocked in Sturgeon Bay, and this is now a nursery area (Kernen, pers. comm. 1979).

WM-4

Ahnapee River (44°36', 87°26') and Kewaunee River (44°28', 87°30'). Historically, muskellunge frequented the estuaries of these rivers, and probably spawned there (Kernen, pers. comm. 1979).

GOLDFISH

No information was found concerning the first appearance of goldfish in Lake Michigan.

Wisconsin

WM-5

Milwaukee (43°02', 87°54'). Successful reproduction apparently occurs in the lower Milwaukee River (43°02', 87°54'). In 1975, eggs were entrained in very small numbers from late May to late June at the Commerce Street Power Plant (43°02', 87°54') on the lower river; larvae were collected from late May to late July. In 1976, a few larvae were also entrained in early July at the Lakeside Power Plant (42°58°, 87°51') (Wis. Elec. Power 1976b).

Illinois

Spawning probably occurs in sheltered lagoons and harbors all along the shore (Muench, pers. comm. 1979).

LAKE CHUB

Lake chubs occasionally move short distances into tributaries to spawn. In Wisconsin, the lake chub usually spawns in mid-April, at about the same time as white suckers and rainbow smelt (Becker 1976).

Wisconsin

Lake chubs are commonly captured with shore seines from Sheboygan (43°45', 87°43') north, around the Door Peninsula (45°05', 87°10'), to Sturgeon Bay (44°53', 87°24'). They are not as prevalent on the Green Bay shore of the Door Peninsula as they are on the shoreline of Lake Michigan proper (Kernen, pers. comm. 1979).

WM-3

Hibbard Creek (44°59', 87°10'). In 1960, lake chubs were collected at the FWS sea lamprey weir in the creek during the spring (FWS 1979c); this may have been a spawning run from Lake Michigan.

WM-4

Kewaunee Power Plant (44°21', 87°32'). Spawning probably occurs in the vicinity of the plant along shore and in intermittent tributaries. Ripe adults were collected near the power plant, and YOY were collected along shore in late June and early July. The substrate in the area is hard clay and cobble-size rock with a few boulders (LaJeone, pers. comm. 1979). In 1976, ripe adults were collected on May 20 onshore near the mouth of an intermittent stream (44°21', 87°32') 1/2 mi N of the plant intake, onshore next to the plant intake, and onshore at Two Creeks (44°18', 87°33') 2 mi S of the plant. Abundance was highest at the mouth of the intermittent creek, which suggests that a spawning run may enter the creek. On June 23, ripe-running or spent lake chubs were collected at the mouth of the intermittent stream and at Two Creeks (LaJeone 1976). Almost 300 eggs were collected at Two Creeks on July 6-7 (Wis. Elec. Power and Wis.-Mich. Power, undated c). Many small lake chubs were collected during July and August 1976 near the intermittent stream; these may have been young-of-the-year (YOY) (LaJeone 1976).

Point Beach Power Plant (44°17', 87°32'). During 1972-76, adults collected near the plant in April were larger than those taken at other times; this suggests that an onshore spawning migration may occur (Wis. Elec. Power and Wis.-Mich. Power, undated b,c).

WM-5

Haven (43°51', 87°44'). Lake chubs spawn in intermittent tributaries in the area. Ripe adults were collected here; YOY were also collected along shore during late June to early July. The substrate is hard clay and cobble-size rock with a few boulders (LaJeone, pers. comm. 1979). Lake chubs apparently migrate into Sevenmile Creek (43°51, 87°44') to spawn. In 1974, running-ripe adults were collected in the creek during May, and spent adults were collected during June and July (Ind. Bio-Test 1977).

Port Washington (43°23', 87°52'). A run enters Sauk Creek (43°23', 87°52') and proceeds 1/2-1 mi upstream (Becker 1976).

Milwaukee (43°02', 87°54'). In 1975, ripe adults were collected in Whitefish Bay (43°08', 87°53') and at North Point (43°04', 87°52') in May and June, when the water temperature was about 44°F; these fish were taken in 30 ft of water over a substrate of rubble, gravel, and some sand (Norden, pers. comm. 1980).

Oak Creek Harbor (42°51', 87°50'). In 1972-73, catches of adults near the Oak Creek Power Plant (42°51', 87°50') peaked during May; these catches were dominated by ripe females that were presumably migrating to shallow water to spawn (Limnetics 1974).

Michigan

MM-1

Cedar River (45°24', 87°21'). In 1955, 1,125 adults were collected at the FWS sea lamprey weir in the Cedar River during the spring (FWS 1979c); this may have been a spawning run from Lake Michigan.

Bark River (45°34', 87°14'). In 1955, 530 lake chubs were collected at the FWS sea lamprey weir in the Bark River during the spring (FWS 1979c); this may have been a spawning run from Lake Michigan.

MM-3

Carp Lake River (45°45', 84°50'). During 1948-51, lake chubs entered the river to spawn, and adults were collected as they migrated downstream after spawning (Applegate and Brynildson 1952).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Lake chubs are rare to uncommon at the plant, but ripe adults are present 1/2 mi S of the plant from early June to early July, over rocks in 18 ft of water (Brazo, pers. comm. 1979).

MM-8

Ganges (42°35', 86°13'). In 1979, gravid females were collected at the mouth of Cove Creek (42°35', 86°14') in 3 ft of water over gravel on May 7 (Owens, pers. comm. 1979).

CARP

The initial plantings of carp were made in the inland waters of the U.S. as early as 1831 (McCrimmon 1968), but the introduction of carp into Lake Michigan is not recorded. Commercial catches of carp in Lake Michigan appear on the first commercial production records started in 1883 (Wells and McLain 1972, 1973).

Wisconsin

WM-1

Green Bay (45°05', 87°25'). Carp may be more abundant in the shallow areas of the bay than elsewhere in Lake Michigan (Wells, pers. comm. 1979). The entire shoreline of western Green Bay from Marinette (45°05', 87°36') south supports a substantial carp population, most of which inhabits the marshes of southern Green Bay (Belonger, pers. comm. 1979; Ebener and Leary, pers. comm. 1979). Spawning usually occurs in the Green Bay area during May and peaks on approximately May 15 (Kernen, pers. comm. 1979), however, spawning has been observed in mid-June (Ebener and Leary, pers. comm. 1979). Carp probably move into many streams in the Green Bay area to spawn. Carp appear to move upstream to spawn following the white sucker runs (Horrall, pers. comm. 1979). Young-of-the-year (YOY) are abundant in southern Green Bay over soft, silty bottom (Belonger, pers. comm. 1979).

Peshtigo Point (44°59', 87°38'). Spawning has been observed in marshy areas here in mid-June (Ebener and Leary, pers. comm. 1979).

Pensaukee (44°49', 87°54') and Little Suamico (44°42', 87°59') Rivers. Spawning runs of carp enter these rivers in early to mid-May (Horrall, pers. comm. 1979).

Fox River (44°32', 88°00'). Carp enter the river to spawn (FWS 1979d). In 1975, carp eggs were entrained at the Pulliam Power Plant (44°32', 88°00') in June; large numbers of early larvae, about 0.2 in. long, were entrained from late May through July. The plant withdraws cooling water from both Green Bay and the Fox River (NALCO, undated a).

Sawyer Harbor (44°53', 87°26'). Carp are present in Sawyer Harbor throughout the year and probably spawn there in marshy areas along the shoreline (Kernen 1972).

WM-3

Rowley Bay (45°13', 87°01'), North Bay (45°09', 87°04'), Moonlight Bay (45°05', 87°05') and Baileys Harbor (45°03', 87°07'). Carp spawn in the marshy areas in these bays during May and June (Frederick, pers. comm. 1979).

WM-4

Ahnapee River (44°36', 87°26'). A spawning run enters the river during May and early June, following the white sucker runs (Horrall, pers. comm. 1979; Imhof, pers. comm. 1979).

Kewaunee (44°27', 87°30'). A spawning run enters the Kewaunee River (44°28', 87°30') during early to mid-May, after the white sucker run (Horrall, pers. comm. 1979).

Kewaunee Power Plant (44°21', 87°32'). In 1975, carp larvae, 0.2-0.4 in. long, were entrained at the plant during July (NALCO, undated b).

Point Beach Power Plant (44°17', 87°32'). Spawning runs are attracted to the discharge of the power plant, and carp are found there in great numbers for a period of time (Reed 1972). In 1973, the greatest concentrations occurred at the plant discharge in April and July; July water temperatures were favorable for spawning, but no spent females were collected (Wis. Elec. Power and Wis.-Mich. Power, undated b).

Sheboygan (43°45', 87°42'). In 1977, a few ripe carp were collected at the discharge of the Edgewater Power Plant (43°43', 87°42') in late May and farther offshore in June. One prolarvae, 0.2 in. long, was captured near the plant on June 15. The area near the plant is not ideal spawning habitat; however the Black River (43°42', 87°42') south of the plant is suitable for spawning (Swanson Environ. 1979).

Illinois

Carp are found in the harbors, embayments, and warmwater discharges of power plants along the Illinois shore, and spawning probably occurs in these areas (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Studies during the 1970s have shown that limited spawning occurs in this area (Cochran and Cima 1974; Commonw. Edison 1976; Raney 1972). Some adults in spawning condition have been seen in the area (Cochran, undated; LaJeone, pers. comm. 1979). A resident population exists in the vegetated intake basin of the Waukegan Generating Station (42°23', 87°49'). Spawning has been observed in the basin, and it also serves as a nursery area (Cima et al. 1976). A few eggs were collected in the inshore waters of the lake in July to September (Ind. Bio-Test 1975a,b; Cima and Cochran, undated; Cima et al. 1976; Cochran and Cima 1974). Eggs were entrained at the Zion Generating Station (42°27', 87°48') as early as mid-April (Cima et al. 1976). Larvae were collected in the area and entrained at the generating station during June to August, indicating an extended spawning season (Ind. Bio-Test 1975a; Cima 1977; Cima et al. 1976; Cochran, undated; Cochran and Cima 1974; LaJeone, pers. comm. 1979).

Indiana

Hammond (41°40', 87°30'). Carp are believed to spawn successfully near the Stateline Generating Station (41°42', 87°31'). In 1975-76, carp exhibiting spawning behavior were frequently observed at night in the station forebay and discharge area, but spawning was not confirmed. Eggs were entrained at the station from late April through August; peak entrainment occurred on May 23-24. Larvae were entrained from May 23 through August; peak entrainment occurred on May 27. Larvae were also collected in the lake and were most abundant inshore, especially near the station discharge (NALCO 1976c).

Gary (41°37', 87°20'). Spawning carp are frequently observed in the discharge canal of the Mitchell Power Station (41°37', 87°22'); these fish are believed to be permanent residents in the canal. Successful spawning occurs in the area. In 1975, many eggs were entrained from May through July; peak entrainment occurred in May. Larvae were entrained from mid-May through July; most were entrained in late May (Krueger 1976; NALCO 1976a).

Burns Ditch (41°38', 87°10'). In 1976, spawning was observed here in June (Tex. Instrum. 1977b).

Bailly Generating Station (41°39', 87°07'). In 1974, a few carp in gravid condition were collected in the immediate vicinity of the station. Spawning may have occurred in the area, but no eggs or larvae were collected (Tex. Instrum. 1975b). In 1976, spawning occurred in the area during June and July and peaked during the first 2 weeks of June and the second week of July (Tex. Instrum. 1977b). In 1976, spawning was observed in the plant discharge canal during June, and eggs were entrained during the first 2 weeks of June, all of July, and the last week of October. Larvae were collected in the plant area from June through August; peak abundance occurred during the last 2 weeks of June and the last 3 weeks of July (Tex. Instrum. 1976c, 1977b).

Michigan City (41°43', 86°54'). In 1976 and 1977, carp exhibiting spawning behavior were observed in the discharge canal of the Michigan City Generating Station (41°43', 86°54') from May through August. The high temperatures of the discharge water extended the spawning period for carp (Morgan 1978a, 1978b).

Michigan

MM-1

Bark River (45°34', 87°14'). In 1978, carp larvae were collected near the river mouth, to depths of 10 ft, from late May to early July (Wis. Elec. Power, unpubl. data).

Ford River (45°40', 87°08'). In 1978, a few carp larvae were collected near the river mouth, to depths of 20 ft, from late May to mid-July (Wis. Elec. Power, unpubl. data).

MM-3

Waugoshance Point (45°45', 85°01'). During 1954 and 1955, carp migrated into the shallows at the point to spawn. In 1955, carp were first observed on June 3 in a cove that had silt and detritus over a gravel bottom. Spawning was observed in 1954 on June 8-13, and in 1955 on June 3-8. In 1954, carp had moved out of the shallows by June 13. In both years, the carp spawning period coincided with that of the smallmouth bass (Latta 1957, 1963).

MM-6

Ludington (43°57', 86°28'). A large population of carp resides in the marsh in the lower Pere Marquette River (43°56', 86°26'). At the Ludington Pumped Storage Plant (43°54', 86°27'), ripe carp (mostly males) are present at depths of less than 10 ft throughout most of the year; abundance increases in late April and peaks from mid-May to late June. The area around the plant lacks vegetation and is not a major spawning ground (Brazo, pers. comm. 1979).

MM-7

Muskegon (43°13', 86°17'). In 1946-69, spawning occurred in June in the southwest corner (43°13', 86°19') of Muskegon Lake in 20-40 ft of water over a sand bottom (Organ et al. 1978).

Port Sheldon (42°54', 86°13'). In 1977, a few carp larvae 0.2-0.3 in. long were entrained at the Campbell Power Plant (42°55', 86°12') in July; larvae were also collected in Lake Michigan near the plant in July (Jude et al. 1978). In 1978, early larvae were entrained from the end of May, at a water temperature of about 64°F, through August, suggesting an extended spawning season (Jude et al. 1979a).

MM-8

Bridgman (41°56', 86°35'). Spawning occurs near the discharge of the Cook Power Plant (41°59', 86°34') over riprap and Cladophora. The adults may be attracted to the plant discharge. Larvae were entrained at the plant and collected in the lake near the plant; no larger YOY were collected near the plant (Jude, pers. comm. 1979; Jude et al. 1979b).

Lakeside (41°51', 86°40'). Since 1916, spawning occurred in an area (41°51', 86°41') just south of Lakeside in May in 10-20 ft of water over a rock bottom (Organ et al. 1978).

EMERALD SHINER

Wisconsin

WM-4

Manitowoc (44°05', 87°39'). Emerald shiners are present here throughout the year and probably spawn in the area (Copes, pers. comm. 1979).

Illinois

It is believed that in 1960, emerald shiners spawned in all the harbors along the Illinois shoreline (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Breeding emerald shiners were collected with dip nets from Waukegan Harbor approximately 20 years ago (Muench, pers. comm. 1979). In 1974, a few young-of-the-year about 1 in. long were collected in the Zion-Waukegan area in August (Ind. Bio-Test 1975).

Wilmette Harbor (42°05', 87°41'). Breeding emerald shiners were collected here with dip nets approximately 20 years ago (Muench, pers. comm. 1979).

Indiana

Bailly Generating Station (41°39', 87°07'). Adult emerald shiners were collected in the area of the generating station; spawning may occur there (Tex. Instrum. 1976a).

Michigan

MM-7

Port Sheldon (42°54', 86°13'). Spawning occurs in the vicinity of Pigeon Lake (42°54', 86°12') from early June to July (Jude et al. 1979a). Emerald shiner larvae are entrained at the Campbell Power Plant (42°55', 86°12'), and a few larvae were collected in the plant discharge area. Pigeon Lake is a major nursery area for emerald shiners (Heufelder, pers. comm. 1979).

COMMON SHINER

Michigan

MM-1

Bark River (45°34', 87°14')--Ford River (45°40', 87°08'). In 1978, common shiner larvae were collected along the shore from the Bark River to the Ford River from late June to late August; most were taken just north of the mouth of the Ford River in mid-July. Larvae were most abundant at about the 5 ft depth contour in mid-June (Wis. Elec. Power, unpubl. data).

MM-3

Waugoshance Point (45°45', 85°01'). In 1954, concentrations of common shiners were observed over smallmouth bass nests. The shiners were assumed to be spawning; male shiners were in breeding colors and had tubercles, and three ripe adults were collected (Latta 1957). Common shiner eggs were also found with smallmouth bass eggs in bass nests. Fry of common shiner and smallmouth bass were collected in the smallmouth bass nesting area (Latta 1963).

Carp Lake River (45°45', 84°50'). In 1948-51, common shiners migrated into Carp Lake to spawn, and adults were collected as they returned to Lake Michigan after spawning (Applegate and Brynildson 1952).

SPOTTAIL SHINER

The spawning and nursery grounds of spottail shiners are probably in water less than 30 ft deep along the entire shoreline of Lake Michigan (Wells and House 1974). Adults are most common in the southeast and extreme southern parts of the lake proper; these areas are probably the primary spawning and nursery grounds (Wells, pers. comm. 1979). Adults are also abundant in Green Bay (45°05', 87°25'), and young-of-the-year (YOY) are found along shore (Belonger, pers. comm. 1979).

Wisconsin

WM-2

Fish Creek Harbor (45°08', 87°15'). Spawning concentrations occur here (Belonger, pers. comm. 1979).

Northport Dock (45°17', 86°59'). Schools of gravid females were observed here (Belonger, pers. comm. 1979).

WM-3

Rowley Bay (45°13', 87°01'), North Bay (45°09', 87°04') and Moonlight Bay (45°05', 87°05'). Running-ripe fish were observed in the shallows of these bays (Frederick, pers. comm. 1979).

WM-4

Manitowoc (44°05', 87°39'). Ripe spottail shiners were collected on shore here during May (Copes, pers. comm. 1979).

WM-5

Milwaukee (43°02', 87°54'). Spottail shiners probably move inshore to spawn. Spawning spottail shiners were collected off Bradford (43°04', 87°52') and McKinley (43°03', 87°53') beaches and the South Shore Yacht Club (43°00', 87°53') in 20-30 ft of water, during the summer (Binkowski, pers. comm. 1979).

Oak Creek Harbor (42°51', 87°50). In 1972-73, ripe females were abundant in March at the Oak Creek Power Plant (42°51', 87°50'); they were assumed to be migrating to shallows to spawn, however, this was earlier than the typical spawning season (Limnetics 1974).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Ripe spottail shiners were collected in this area (LaJeone, pers. comm. 1979; Muench, pers. comm. 1979). The substrate in this area is fine sand with a few rocks (LaJeone, pers. comm. 1979). In 1972, spottail shiners were observed in spawning condition in the vicinity of the Zion (42°27', 87°48') and Waukegan (42°23', 87°49') generating stations (Cochran, undated). Spottail shiners spawn from June to August but spawning success in this area is limited. In 1973, a few larvae were collected in the area in July and August (Cochran and Cima 1974). In 1974, one YOY was captured in August, and three others were captured in October (Ind. Bio-Test 1975).

Indiana

Hammond (41°40', 87°30'). In 1975-76, spottail shiners were believed to have spawned successfully in the vicinity of the Stateline Generating Station (41°42', 87°31'); spottail shiner eggs were less than 0.1% of the eggs taken in the lake and spottail shiner larvae were only 0.5% of the larvae taken in the lake (NALCO 1976).

Bailly Generating Station (41°39', 87°07'). Spottail shiners spawn in the area adjacent to the plant from the third week in May through the third week in July. Spawning is heaviest in water shallower than 30 ft (Tex. Instrum. 1975b, 1977b). Limited spawning is thought to occur in the station discharge area (Tex. Instrum. 1976c). Spottail shiners captured in beach seines in May were probably in the area to spawn (Tex. Instrum. 1975b). Spottail shiner eggs were entrained at the station from late April through July; peak abundance occurred in June and early July. Larvae were entrained during June to August; peak abundance occurred from late June through July (Tex. Instrum. 1976c, 1977b). Catches of YOY in beach seines indicate that spottail shiners use this area as a nursery ground through October (Tex. Instrum. 1975b, 1976b). Adults and first year juveniles probably moved offshore to deeper waters in early fall (Tex. Instrum. 1975b).

Michigan City (41°43', 86°54'). Spottail shiners spawn along shore from the Michigan state line (41°46', 86°49') to the Indiana Dunes (41°40', 87°02'). Ripe adults were collected here in large numbers from June through August. Spawning occurred in late July and August in waters often 1 ft deep or less (McComish, pers. comm. 1979). Spawning adults were collected at Kintzele Ditch (41°43', 86°56') about 1 mi W of Michigan City (Palacios, pers. comm. 1979). Sharply reduced catches of adults in October indicate that they migrate offshore in the fall (McComish, pers. comm. 1979; Willis 1975). The nearshore waters are an important nursery area for spottail shiners; YOY are evenly distributed along shore (McComish, pers. comm. 1979). About 8% of the total larvae entrained at the Michigan City Generating Station (41°43', 86°54') were spottail shiners (Morgan 1978a). Young-of-the-year were collected at Kintzele Ditch (Palacios, pers. comm. 1979). In 1979, YOY were collected along the Indiana Dunes in 15 ft of water during August (Koch, pers. comm. 1979).

Michigan

MM-1

Bark River (45°34', 87°14')--Ford River (45°40', 87°08'). In 1978, larvae were common in this area. They were collected onshore during May 31 to August 15 and out to the 10 ft depth contour beginning in June (Wis. Elec. Power, unpubl. data).

Little Bay de Noc (45°45', 87°00'). Spottail shiners spawn in Little Bay de Noc from mid-June through July (Basch 1968).

MM-4

Grand Traverse Bay (45°05', 85°30'). Spottail shiners spawn on sandy shoals or in stream mouths during the spring and summer (Price and Kelly 1976).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). In 1972, several ripe females were collected here on August 28. This suggests that there may be two discrete spawning periods during the year because spawning usually occurs during June and July (Liston and Tack 1973). Ripe adults were present from approximately mid-June to the end of July; peak abundance occurs in July. The greatest concentrations of ripe adults was found near shore approximately 2 mi S of the plant; ripe adults were also collected to depths of 15 ft (Brazo, pers. comm. 1979). Larvae were present from late June throughout the summer; they were most abundant at the 5 ft depth contour. Young-of-the-year about 1 in. long were captured in mid-August (Brazo, pers. comm. 1979; Liston et al. 1978).

MM-7

Port Sheldon (42°54', 86°13'). The high concentrations of adults in the nearshore zone here indicate that spawning occurs during May to August (Jude et al. 1978, 1979a). In 1977, eggs were collected along the beach north of the Campbell Power Plant (42°55', 86°12') in late June; spawning may occur in the vicinity of the plant discharge canal (Jude et al. 1978). Spawning also occurs in Pigeon Lake (42°54', 86°12') (Jude et al. 1979a). In 1974, some spottail shiner eggs were entrained at the plant in early May; these were believed to have been released prematurely by entrained fish (Consumers Power 1976b). The nearshore area of Lake Michigan is a nursery ground for spottail shiners. Larvae were first collected at two beach stations, north and south of the discharge canal, in early June. These early larvae may have resulted from spawning near or in the discharge canal during May. Larvae were collected through August, and abundance peaked in late July. Larvae were found almost exclusively near shore. Young-of-the-year were collected at depths of 20 ft or less until October, when they moved to deeper water (Consumers Power 1977; Jude et al. 1978, 1979a).

In southeast Lake Michigan, spottail shiners spawn in the nearshore zone during June to August (Wells and House 1974).

Palisades Power Plant (42°19', 86°19'). Large numbers of ripe spottail shiners moved into the beach zone beginning in late May; spawning occurred primarily in June and July (Consumers Power 1972b; Wapora 1979c,d). Few adults were present in the area after August (Wapora 1979d). Spottail shiner eggs were collected in the area and entrained at the power plant beginning in late June (Wapora 1979c). Many early larvae were found in the beach zone; in 1978, 97% of the larvae collected were less than about 0.3 in. long (Wapora 1979c). Many YOY were captured in the area from July to September (Patriarche 1972b; Wapora 1979d).

Bridgman (41°56', 86°35'). Spawning generally occurs in the vicinity between the Cook Power Plant (41°59', 86°34') and Warren Dunes (41°54', 86°37') from June to August at water temperatures of 64-72°F. Adults begin moving inshore as early as March; peak abundance occurs in June (Indiana and Mich. Power 1975; Jude 1976a, pers. comm. 1979; Jude et al. 1975, 1979b). Adults are most abundant inside the 20 ft depth contour, and spawning occurs along the entire shoreline in water less than 10 ft deep (Indiana and Mich. Power 1975; Jude, pers. comm. 1979; Jude et al. 1975, 1979b). Divers observed female spottail shiners depositing eggs on Cladophora at the water intake crib of the power plant in mid-June; an estimated 500-1,000 ripe males and females were observed above and in the Cladophora. Eggs were collected here, reared in the laboratory, and identified as spottail shiners (Indiana and Mich. Power 1975; Jude 1976a, pers. comm. 1979; Jude et al. 1975, 1979b). Adults dispersed from the beach zone to deeper offshore waters in July and August after spawning (Indiana and Mich. Power 1975; Jude et al. 1975, 1979b). The nearshore area is also a nursery ground for spottail shiners (Indiana and Mich. Power 1975; Jude, pers. comm. 1979). Newly hatched larvae were usually present from early June to August; YOY first appeared in beach seine catches in July or August (Jude 1977; Jude et al. 1973, 1975, 1979b).

BLUNTNOSE MINNOW

Illinois

Ripe adults were collected along the entire Illinois shoreline (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In 1975, a few larvae were collected in this area in July (Cima et al. 1976).

Michigan

MM-1

Ford River (45°40', 87°08'). In 1978, larvae were collected in seines off the mouth of the river from June to October (Wis. Elec. Power, unpubl. data).

MM-7

Port Sheldon (42°54', 86°13'). In 1978, a few young-of-the-year were taken along the beach during September (Jude et al. 1979a).

FATHEAD MINNOW

The habitat requirements of fathead minnows suggest that this species does not reproduce successfully in Lake Michigan proper (CDM/Limnetics 1976c).

Illinois

Ripe adults were collected along the entire Illinois shoreline (Muench, pers. comm. 1979).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In 1972, adults in spawning condition were observed in this area (Cochran, undated).

LONGNOSE DACE

Wisconsin

Longnose dace are common along the shoreline from Sheboygan (43°45', 87°43') north, around the Door Peninsula (45°05', 87°10'), to Sturgeon Bay (44°53', 87°24') (Kernen, pers. comm. 1979).

WM-4

Kewaunee Power Plant (44°21', 87°32'). In 1975, ripe longnose dace were collected on June 23 onshore in an area (44°21', 87°32') approximately 1/2 mi N of the plant, at the power plant, and at Two Creeks (44°18', 87°33') 2 mi S of the plant at water temperatures of 47-49°F. Ripe-running and spent fish were collected on July 21 when the water temperature was about 52°F. A few young-of-the-year (YOY) were collected during September and October (LaJeone 1976b, pers. comm. 1979).

WM-5

Haven (43°51', 87°44'). Adults in spawning condition and YOY were collected here in June and July. The substrate consists of hard clay and cobble-size rock with a few boulders (LaJeone, pers. comm. 1979). In 1974, ripe longnose dace were collected in the area during May and June (Ind. Bio-Test 1977; Wis. Elec. Power et al. 1979a, b). Peak abundance of ripe adults occurred in May along shore, and spawning apparently occurred along shore in June. In 1977, longnose dace migrated into Sevenmile Creek (43°51', 87°44'); this may have been a spawning run (Ind. Bio-Test 1977).

Port Washington (43°23', 87°52'). In 1975, ripe adults were impinged at the Port Washington Power Plant (47°23', 87°52') in late June and early July (Wis. Elec. Power 1976e).

Milwaukee (43°02', 87°54'). In 1971-75, longnose dace were observed spawning at McKinley Beach (43°03', 87°53') in 3-8 in. of water along the shore. The substrate is sandy with many rocks approximately 3 in. in diameter. Adults with spawning colors and running milt were collected among the rocks. After 1975, longnose dace were no longer found in the area (Binkowski, pers. comm. 1979).

Oak Creek Harbor (42°51', 87°50'). Longnose dace larvae were entrained at the Oak Creek Power Plant (42°51', 87°50') (CDM/Limnetics 1977).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Ripe longnose dace were collected inshore from the Wisconsin state line (42°29', 87°48') south to the Great Lakes Naval Training Center (42°18', 87°50') (Muench, pers. comm. 1979). Young-of-the-year were collected in the Zion-Waukegan area over a substrate of fine sand with a few rocks (LaJeone, pers. comm. 1974). During 1972, longnose dace in spawning condition were observed near the Zion (42°27', 87°48') and Waukegan (42°23', 87°49') generating stations (Cochran, undated). A few YOY were collected in this area in the fall (Ind. Bio-Test 1975; Cima et al. 1976).

Michigan

MM-1

Bark River (45°34', 87°14')--Ford River (45°40', 87°08'). In 1978, longnose dace larvae were collected in this area in late May and June; they were more abundant near the Bark River than the Ford River (Wis. Elec. Power, unpubl. data).

MM-3

Carp Lake River (45°45', 84°50'). In 1948-51, longnose dace migrated into the river to spawn; adults left the river after spawning (Applegate and Brynildson 1952).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). In 1975-76, onshore migrations of longnose dace occurred in mid-May when water temperatures were about 46-57°F. Ripe adults were first collected in mid-May; all were spent by late July. Spawning peaked from late June to early July at about 57-66°F (Brazo et al. 1978, pers. comm. 1979). Many adults entered the surf zone within the 10 ft depth contour in mid-May to spawn; these fish were present in the surf zone only at night (Brazo et al. 1978). Ripe adults and YOY about 1 in. long were most abundant on a gravel bar (43°51', 86°26'), 2 mi S of the plant (Brazo, pers. comm. 1979). Fry 0.7-0.8 in. long were first collected in early August (Brazo et al. 1978).

CYPRINID spp.

Wisconsin

WM-4

Kewaunee Power Plant (44°21', 87°32'). Several species of minnows spawn along much of the shoreline in the vicinity of the plant (USAEC 1972e).

Indiana

Bailly Generating Station (41°39', 87°07'). In 1976, cyprinid eggs and larvae were entrained at the station during June and July (Tex. Instrum. 1977b). In 1978, cyprinid eggs were collected directly off the plant discharge at the 5 ft depth contour (Tex. Instrum. 1979).

Michigan

MM-1

Bark River (45°34', 87°14'). In 1978, a few cyprinid eggs were collected just north of the river mouth at the 5 ft depth contour on May 24 (Wis. Elec. Power, unpubl. data).

MM-7

Port Sheldon (42°54', 86°13'). During 1977, high numbers of unidentified cyprinid larvae were entrained at the Campbell Power Plant (42°55', 86°12'); peak entrainment occurred from early June to early August. In 1977, more than 765,000 larvae were entrained on July 8;

larvae were also found along the Lake Michigan beach near the plant in late July (Jude et al. 1978, 1979a).

QUILLBACK

Michigan

MM-7

Port Sheldon (42°54', 86°13'). In 1978, three quillbacks captured at the Campbell Power Plant (42°55', 86°12') in June and July had well developed gonads. Many young-of-the-year were observed in the plant discharge canal in July; spawning may occur there (Heufelder, pers. comm. 1979; Jude et al. 1979a).

LONGNOSE SUCKER

Longnose suckers are abundant in Green Bay (45°05', 87°25') and are also probably found in most of the shallow areas of Lake Michigan proper (Wells, pers. comm. 1979). Prior to 1966, most of the commercial catches of longnose suckers were from the northeast section of the lake (USBCF 1965; USDI 1966).

Wisconsin

WM-1

Pensaukee River (44°49', 87°54'). The river supports a commercial fishery for longnose suckers during the spawning run (Belonger, pers. comm. 1979).

WM-3

It is believed that longnose suckers spawn along the shoreline and in bays of the Door Peninsula; they apparently do not spawn in many tributaries in this area (Imhof, pers. comm. 1979).

Rowley (45°13', 87°01'), North (45°09', 87°04'), and Moonlight (45°05', 87°05') Bays. Longnose suckers enter the bays to spawn following the white sucker runs which occur in April (Frederick, pers. comm. 1979).

Baileys Harbor (45°03', 87°07'). A spawning run occurs here in June (Frederick, pers. comm. 1979).

Hibbard Creek (44°59', 87°10'). In 1971, many spawning adults were present in the creek (GLFC 1973).

WM-4

Kewaunee Power Plant (44°21', 87°32'). Tributaries in the vicinity probably serve as spawning and nursery areas for longnose suckers (LaJeone 1976).

Point Beach Power Plant (44°17', 87°32'). Catches of longnose suckers here increase markedly between February and May and peak in April and May. Spent females were collected throughout the area after May; no gravid females were taken after June (Limnetics 1974; Wis. Elec. Power, undated; Wis. Elec. Power and Wis.-Mich. Power, undated a, b). Larvae were collected at the power plant (CDM/Limnetics 1977).

WM-5

Oak Creek Harbor (42°51', 87°50'). No gravid female longnose suckers are found in the area after March, when presumably they move into rivers in the area to spawn (Limnetics 1974).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Spawning occurs in the area; successful spawning is believed to be limited (Cochran and Cima 1974; Commonw. Edison 1976). In 1974, one egg, but no larvae, were found here in May (Cochran and Cima 1974).

Michigan

MM-1

Cedar River (45°24', 87°21'). In 1976, many thousands of spawning adults entered the river (Dahl and McDonald 1980; GLFC 1979a).

Bark River (45°34', 87°14'). In 1955, longnose suckers were collected at the FWS sea lamprey weir in the spring (FWS 1979c); these catches suggest that a spawning run enters the river.

Ford River (45°40', 87°08'). A spawning run of longnose suckers enters the Ford River; the run occurs one to two weeks after the white sucker runs (Michaud, pers. comm. 1980).

Days (45°54', 86°59'), Sturgeon (45°50', 86°40'), and Fishdam (45°54', 86°35'), rivers. In 1954 and 1955, longnose suckers were collected at FWS sea lamprey weirs on these rivers in the spring (FWS 1979c); these catches suggest that spawning runs enter the rivers.

MM-3

Rock River (46°05', 85°32'). In 1955, longnose suckers were collected at the FWS sea lamprey weir in the spring (FWS 1979c); these catches suggest that a spawning run enters the river.

MM-5

Platte River (44°44', 86°09'). Spawning runs occurred here in 1942 and 1943 (Carbine and Shetter 1945; Westerman 1942).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Ripe longnose suckers were found in shallow water during April within the area one mi N and S of the plant. These fish were probably migrating through the area to spawn in nearby rivers (Brazo, pers. comm. 1979). In 1972, both ripe and spent males and females were collected within the 30 ft depth contour during April and May (Liston and Tack 1972).

MM-7

Port Sheldon (42°54', 86°13'). Gonad analyses of fish collected in 1978 indicated that spawning probably took place here in May. Low catches of longnose suckers in April suggested that this species may spawn in streams and rivers in the area (Jude et al. 1979a).

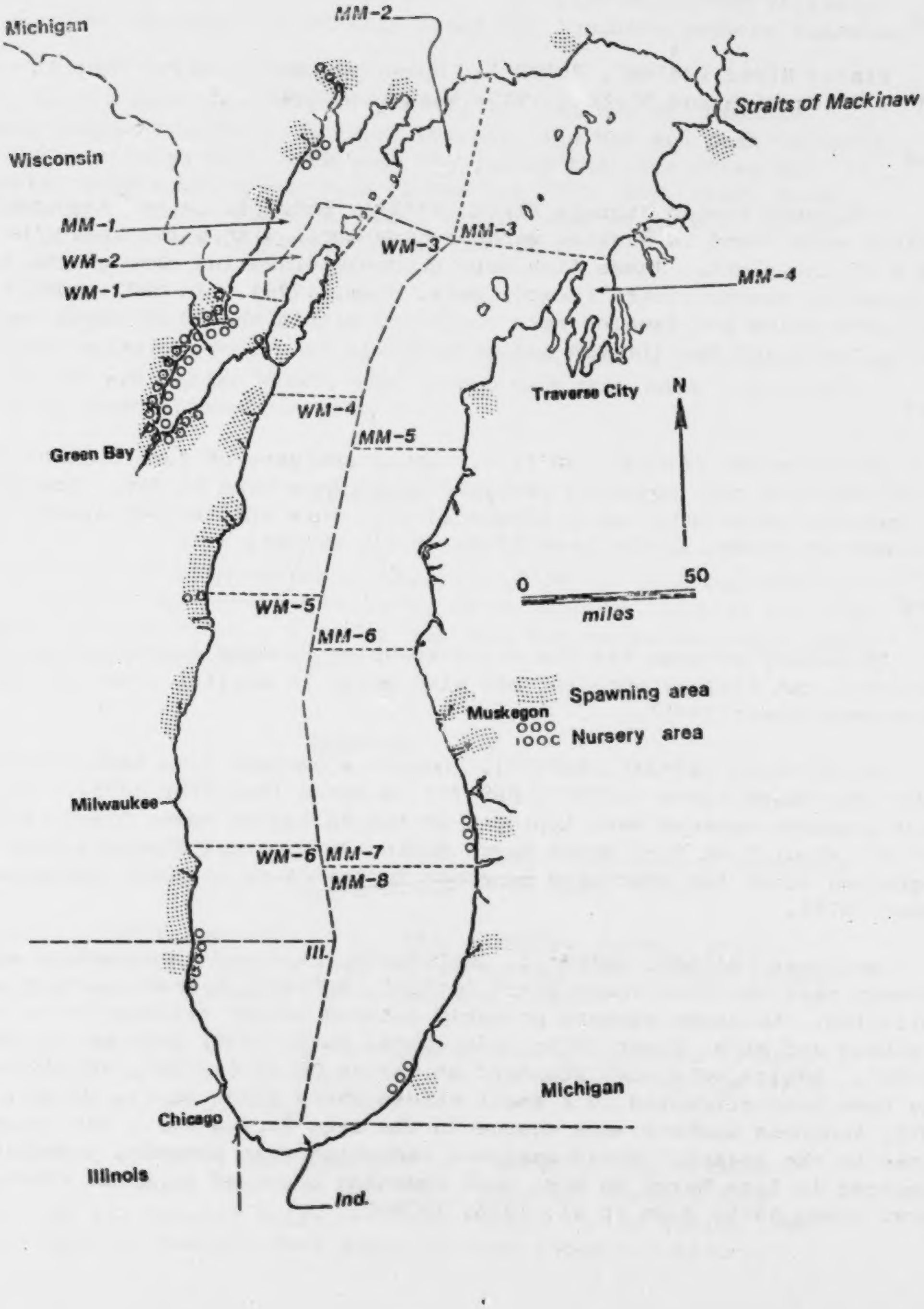
MM-8

Tributary streams are the major spawning grounds in eastern Lake Michigan, but limited spawning may also occur in shallow areas of the lake (Consumers Power 1975).

South Haven (42°24', 86°17'). Longnose suckers from Lake Michigan enter the Black River (44°24', 86°17') to spawn (Stauffer 1972). In 1973, many longnose suckers were impinged at the Palisades Power Plant (42°19', 86°19') about 5 mi S of South Haven during June; these fish may have been migrating along the shoreline en route to tributary streams (Consumers Power 1975).

Bridgman (41°56', 86°35'). In 1973-74, ripe and spent adults were present near the Cook Power Plant (41°59', 86°34'); however no eggs were collected. Longnose suckers probably entered nearby tributaries to spawn (Indiana and Mich. Power 1975; Jude, pers. comm. 1979; Jude et al. 1975, 1979b). Adults were most abundant at Warren Dunes (41°54', 86°37') and may have been attracted to a small stream there (Jude et al. 1979b). In 1973, longnose suckers were scarce in the area during April but reappeared later in the season. Gonad analyses indicated that spawning probably occurred in late March to May; most spawning occurred in April (Jude, pers. comm. 1979; Jude et al. 1975, 1979b).

WHITE SUCKER


MM-2
Michigan
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
WM-4
MM-5
Green Bay
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

White suckers enter Lake Michigan tributaries to spawn; spawning also presumably occurs in the shallows of the lake (USBCF 1965; USDI 1966). White suckers are harvested by fishermen during the spawning runs (CDM/Limnetics 1976c).

Wisconsin

WM-1

The Wisconsin tributaries along the west shore of Green Bay have substantial runs of white suckers. Runs occur in the spring in almost all of the tributaries to the bay that have a continuous flow (Belonger, pers. comm. 1979; Horrall, pers. comm. 1979). Runs usually occur during late March or early April to early May at water temperatures of 46-64°F and peak at water temperatures of approximately 57°F; runs sometimes occur under the ice. Limited spawning may occur in the lake. Spawning areas are probably also nursery areas. Larvae may remain in the streams for 5-6 months (occasionally up to one year) before migrating to the lake (Horrall, pers. comm. 1979). Young-of-the-year (YOY) inhabit the western shore of Green Bay (Belonger, pers. comm. 1979).

Little River (45°03', 87°38'). In 1955, white suckers were collected at the FWS sea lamprey weir in the spring (FWS 1979c); this catch suggests that a spawning run from the lake enters the river.

Peshtigo River (44°58', 87°39') (Horrall, pers. comm. 1979). Removal of dams on the river would increase access to prime spawning grounds (GLFC 1979b).

Oconto River (44°54', 87°50') (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980). Removal of dams on the river would increase access to prime spawning grounds (GLFC 1979b).

Pensaukee River (44°49', 87°54') (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980). Substantial runs supporting commercial production enter the river (Belonger, pers. comm. 1979). Thousands of white suckers (160,000 in 1957) were collected at the FWS sea lamprey weir during the spawning migration (Dahl and McDonald 1980; FWS 1979c).

Little Suamico River (44°42', 87°59') (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980).

Big Suamico River (44°38', 88°00') (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980). Substantial runs supporting commercial production enter the river (Belonger, pers. comm. 1979).

Duck Creek (44°34', 88°02') (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980).

Fox River (44°32', 88°00'). White sucker eggs and larvae were entrained during April and May at the Pulliam Power Plant (44°32', 88°00'), which withdraws water from both Green Bay (45°05', 87°25') and the Fox River (CDM/Limnetics 1977; NALCO, undated a).

Point Sable Creek (44°35', 87°54') (Imhof, pers. comm. 1980).

Red River (44°40', 87°45'). Spawning runs occur in April (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980).

Sturgeon Bay (44°53', 87°24'). Spawning occurs in the bay in late April (Moore, pers. comm. 1979). White suckers may be found in Sawyer Harbor (44°53', 87°26') throughout the year; spawning may occur along the marshy shoreline of the bay (Kernen 1972).

WM-3

Rowley Bay (45°13', 87°01'), North Bay (45°09', 87°04'), and Moonlight Bay (45°05', 87°05') and Baileys Harbor (45°03', 87°07'). White suckers enter these bays to spawn prior to the longnose sucker runs (Frederick, pers. comm. 1979).

Hibbard Creek (44°59', 87°10') (Imhof, pers. comm. 1980). Large numbers of spawning white suckers were found in the creek (GLFC 1973).

Lily Bay Creek (44°51', 87°16'). In 1955, white suckers were collected at the FWS sea lamprey weir in the spring (FWS 1979c); this catch suggests that a spawning run enters the creek from the lake.

WM-4

Stony Creek (44°40', 87°23') (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980).

Ahnapee River (44°36', 87°26') (Frederick, pers. comm. 1979; Horrall, pers. comm. 1979; Imhof, pers. comm. 1980).

Three Mile Creek (44°34', 87°27') (Horrall, pers. comm. 1979; Imhof, pers. comm. 1980).

Mashek Creek (44°30', 87°29') (Imhof, pers. comm. 1980).

Kewaunee River (44°28', 87°30'). Very large white sucker spawning runs enter the river; the runs may begin under the ice and continue until late April or early May (Frederick, pers. comm. 1979; Horrall, pers. comm. 1979; Imhof, pers. comm. 1980).

Point Beach Power Plant (44°17', 87°32'). In 1973, gravid females were collected from November through March; no ripe females were collected after March (Wis. Elec. Power and Wis.-Mich. Power, undated a).

Molash Creek (44°11', 87°31') (Weber, Desparte, and Threinen 1968).

East (44°09', 87°34') and West (44°09', 87°34') Twin Rivers (Belonger, pers. comm. 1979; Imhof, pers. comm. 1980; Weber, Desparte, and Threinen 1968).

Little Manitowoc River (44°06', 87°39') (Weber, Desparte, and Threinen 1968).

Manitowoc River (44°05', 87°39') (Belonger, pers. comm. 1979; Weber, Desparte, and Threinen 1968).

Silver (44°04', 87°39'), Calvin (44°02', 87°40'), Pine (43°59', 87°42'), Point (43°58', 87°42'), and Centerville (43°55', 87°43') Creeks (Weber, Desparte, and Threinen 1968).

WM-5

Sevenmile Creek (43°51', 87°44'). A few ripe adults were found in the creek in April, when few adults were found in the lake; adults reappeared in the lake in June and July when adults were no longer found in the creek. This pattern of distribution and absence of eggs, larvae, and YOY in the lake, indicates that white suckers entered area streams to spawn. Eggs, larvae, and YOY were found in Sevenmile Creek (Ind. Bio-Test 1977; LaJeone, pers. comm. 1979; Wis. Elec. Power et al. 1979a,b).

Pigeon River (43°47', 87°43'). A spring run enters the river; a large dip net fishery for white suckers occurs along the entire length of the river (Weber, Poff, and Threinen 1968).

Sheboygan (43°45', 87°42'). A spawning run enters the Sheboygan River (43°45', 87°42') (Imhof, pers. comm. 1980). In 1975, small numbers of ripe adults were impinged at the Edgewater Generating Station (43°43', 87°42') in mid-March to April (Swanson Environ. 1976).

Ozaukee County (43°33', 87°48'--43°12', 87°54'). Spring spawning runs enter the tributaries (Poff et al. 1964).

WM-6

Racine County (42°49', 87°49'--42°40', 87°48'). Early spring runs enter the tributaries (Poff and Threinen 1961a).

Kenosha County (42°40', 87°48'--42°29', 87°48'). Early spring runs enter tributaries. The Pike River (42°36', 87°49') supports an important run; runs formerly entered Barnes Creek (42°31', 87°49') (Poff and Threinen 1961b).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). White suckers spawn in this area, however, spawning success appears to be limited

(Cochran and Cima 1974). Ripe adults were collected as they entered the Dead River (42°24', 87°48') during April (Muench, pers. comm. 1979). In 1973-75, a few eggs were collected in the area from February through June (Cochran and Cima 1974; Cima et al. 1976). In 1975, a few larvae were found in the lake during April and May (Cima et al. 1976). During June and July, YOY were collected in beach seines near the Waukegan Generating Station (42°23', 87°49') (Cochran, undated).

Michigan

MM-1

Cedar River (45°24', 87°21'). Spawning runs enter the river during early April (Imhof, pers. comm. 1980; Leary, pers. comm. 1979). Many thousands of spawning white suckers were observed in the river (Dahl and McDonald 1980; GLFC 1979a).

Bark River (45°34', 87°14'). In 1955, white suckers were collected at the FWS sea lamprey weir in the spring (FWS 1979c); this catch suggests that a spawning run from the lake enters the river. In 1978, larvae were collected in seines near the river mouth from May 26 to June 12 (Wis. Elec. Power, unpubl. data).

Ford River (45°40', 87°08'). White sucker spawning runs enter the river about one to two weeks before the longnose sucker runs. In 1978, white sucker larvae were collected in seines near the river from May 26 to June 12; peak densities occurred on May 31 (Michaud, pers. comm. 1980; Wis. Elec. Power, unpubl. data).

Days River (45°54', 86°59'). In 1960-65, white suckers were observed migrating up the Days River during the end of April and early May. Ripe adults and larvae were collected from the stream (Norden, pers. comm. 1979).

Tacoosh (45°55', 86°58'), Rapid (45°55', 86°58'), Sturgeon (45°50', 86°40'), and Fishdam (45°54', 86°35') rivers. In 1954 and 1955, white suckers were collected at the FWS sea lamprey weirs on these rivers in the spring (FWS 1979c); these catches suggest that spawning runs from the lake enter the river.

MM-3

Rock River (46°05', 85°32'). In 1975 and 1976, white suckers were collected at the FWS sea lamprey weir in the spring (FWS 1979c); these catches suggest that a spawning run from the lake enters the river.

Carp Lake River (45°45', 84°50'). From 1948-51, white suckers migrated into the river to spawn, and adults were collected when they migrated downstream after spawning (Applegate and Brynildson 1952).

MM-5

Platte River (44°44', 86°09'). A spawning run occurred here in 1942 (Westerman 1942).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Ripe white suckers are collected during April just north and south of the plant. Spent adults are present in late May. No larvae were collected at the plant; spawning probably occurs in the nearby tributaries (Brazo, pers. comm. 1979; Liston and Tack 1972).

MM-7

White River (43°25', 86°21'). In 1969, large numbers of spawning white suckers were found in the river (GLFC 1970a,b).

Muskegon (43°13', 86°17'). In 1974-75, peak impingement at the Cobb Power Plant (43°16', 86°15') on Muskegon Lake (43°14', 86°18') occurred from mid-April to mid-May (Consumers Powers 1976f); this corresponds to the spawning period and suggests that a run enters the Muskegon River (43°15', 86°15') from the lake. Many white suckers were captured at the FWS weir here in April-July (Dahl and McDonald 1980).

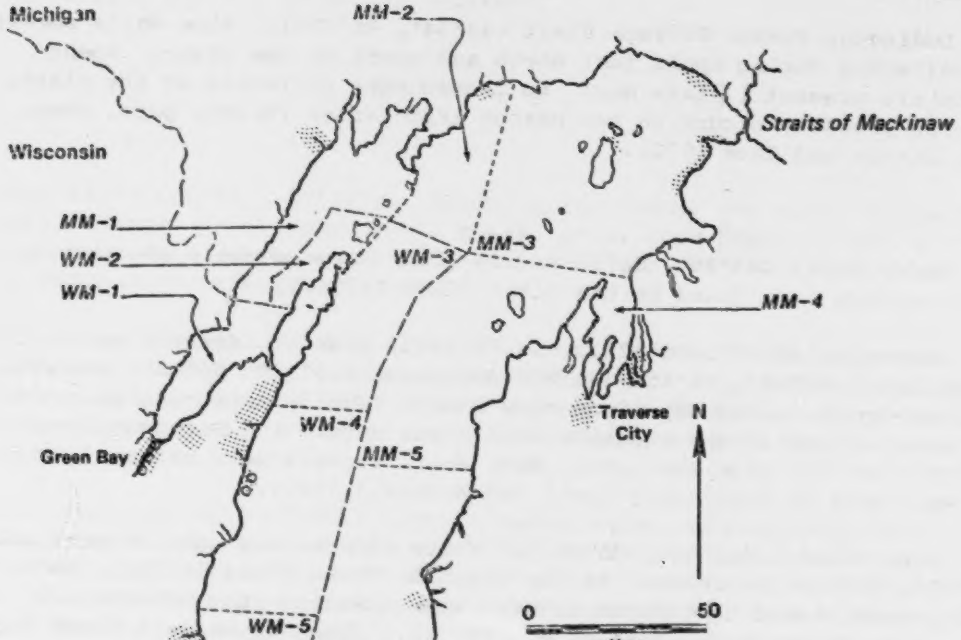
Port Sheldon (42°54', 86°13'). White suckers may enter Pigeon Lake (42°54', 86°12') to spawn. At the Campbell Power Plant (42°55', 86°12'), impingement peaked from March to May, when spawning runs occurred (Consumers Power 1976b; Jude et al. 1979a). Some larvae were found here in May (Jude et al. 1979a).

MM-8

Black River (42°24', 86°17'). White suckers enter this river from Lake Michigan to spawn (Stauffer 1972).

Bridgman (41°56', 86°35'). Spawning probably occurs here in late March through May. Although common in the area, few white suckers were collected during April, and it is suspected that adults leave the vicinity or enter area streams to spawn. The numbers of spent fish present in the area increased after April. A few YOY were collected in beach seines and observed in a creek at Warren Dunes (41°54', 86°37') (Jude, pers. comm. 1979; Jude et al. 1975, 1979b).

SUCKER spp.


Michigan
MM-2
Wisconsin
Straits of Mackinaw
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Nursery area
Muskegon
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

The abundance of suckers in Lake Michigan may have declined because spawning streams, particularly those in Green Bay have been degraded (Wells and McLain 1973).

Wisconsin

Suckers commonly enter tributaries along the western shore of Lake Michigan in March and April to spawn (Wis. Elec. Power 1975a,b,c). Suckers are seasonal migrants in most Green Bay and Lake Michigan tributaries of Door County (Poff and Threinen 1965).

WM-1

Fox River (44°32', 88°00'). Suckers enter the river in the spring to spawn (FWS 1979d). Catostomid larvae were entrained at the Pulliam Power Plant (44°32', 88°00'), which withdraws water from the river and from Green Bay (CDM/Limnetics 1977).

Red River (44°40', 87°45'). A fishery for suckers occurs at the river mouth in the spring (Poff and Threinen 1966b).

WM-3

Heins Creek (45°01', 87°09'). A spawning run may enter the creek (Poff and Threinen 1965).

Woodard Creek (44°45', 87°20'). Suckers may spawn near the creek mouth (Poff and Threinen 1965).

Bear Creek (44°42', 87°21'). A spawning run enters the creek in the spring (Poff and Threinen 1965).

WM-4

Ahnapee (44°36', 87°26') and Kewaunee (44°28', 87°30') Rivers. A fishery for suckers occurs at the river mouths in the spring (Poff and Threinen 1966b).

Kewaunee Power Plant (44°21', 87°32'). In 1975, catostomid eggs were entrained at the plant in late April and mid-May; a few larvae were also entrained (CDM/Limnetics 1977; NALCO, undated b).

WM-5

Sheboygan River (43°45', 87°42'). A fishery for suckers occurs at the river mouth in the spring (USDI 1966).

Milwaukee (43°02', 87°54'). A spawning run of suckers entered the Milwaukee River (43°02', 87°54'), but by 1885 the fishery was almost entirely abandoned (Gregory 1931 as cited in Poff and Theinen 1964; Smith and Snell 1891). Runs presently occur in the Milwaukee and Kinnickinnic (43°02', 87°54') rivers (Poff and Threinen 1964).

Indiana

Burns Waterway (41°38', 87°10') and Trail Creek (41°44', 86°54'). Suckers enter these tributaries to spawn (Koch, pers. comm. 1979).

Michigan

MM-1

Ford River (45°40', 87°08'). In 1978, sucker eggs (> 19,000 per m^3) were collected in large numbers near the river mouth at the 5 ft depth contour on May 11, after heavy rains washed them out of the river (Wis. Elec. Power, unpubl. data).

MM-2

Manistique (45°57', 86°15'). Suckers spawned in an area (45°55', 86°18'--45°56', 86°16') near the mouth of the Manistique River (45°57', 86°15); the substrate was honeycombed rock, and the water depth was about 12 ft (Organ et al. 1978).

MM-3

Beaver Island (45°40', 85°33'). Runs of suckers occurred here. In 1885, suckers were caught in seines as they entered St. James Harbor (45°45', 85°31') in the spring (Smith and Snell 1891).

Brevort (46°01', 85°02'). From the 1960s to 1976, suckers spawned along the shoreline from the Brevoort River (45°57', 84°56') to the Cut River (46°03', 85°07'), over sand and rock in approximately 4-5 ft of water, during late June to early July (Organ et al. 1978).

Waugoshance Island (45°46', 85°04')--Good Hart (45°34', 85°07'). During the 1930s to 1950s, suckers spawned here at depths of less than 12 ft from May to mid-June. The substrate around Waugoshance Island and Waugoshance Point (45°45', 85°01') is primarily rock and mud; elsewhere along the shoreline the substrate is gravel and sand (Organ et al. 1978).

Callam's Mill (location unknown). In 1885, suckers were captured in seines here in early May (Smith and Snell 1891).

MM-4

Grand Traverse Bay (45°05', 85°30'). The first dams were erected on the Elk River (44°54', 85°25') and Kid's Creek (44°46', 85°38') in 1847 and 1851 respectively; these dams blocked the upstream spawning migration of suckers (Price and Kelly 1976).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Spawning occurred on a small area (43°52', 86°29') of rock and hard clay south of the plant, offshore at a depth of about 100 ft (Organ et al. 1978).

MM-7

Port Sheldon (42°54', 86°13'). In 1978, sucker larvae were collected here in May (Jude et al. 1979a).

MM-8

Galien River (41°48', 86°45'). Suckers were abundant in the river during the spawning season in early spring (Hankinson 1920).

St. Joseph (42°06', 86°29'). From the 1940s to 1960, spawning occurred on a shallow, sand area (42°05', 86°30') just south of St. Joseph (Organ et al. 1978).

BUFFALO spp.

Indiana

Spawning runs of buffalo enter streams along the Indiana shoreline (Westerman, pers. comm. 1979).

GOLDEN REDHORSE

Wisconsin

WM-1

Peshtigo (44°58', 87°39'), Menominee (45°06', 87°35'), and Oconto (44°54', 87°50') Rivers. Golden redhorses are found in these rivers. It is believed that most of these are stream residents but some fish may enter these streams from the lake to spawn. Golden redhorse runs in this area tend to occur later than sucker runs (Moore, pers. comm. 1979).

Michigan

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). A few ripe golden redhorses were collected at the 5 ft depth contour in April (Brazo, pers. comm. 1979).

SHORTHEAD REDHORSE

Wisconsin

WM-1

Menominee (45°06', 87°35'), Peshtigo (44°58', 87°39'), and Oconto (44°54', 87°50') Rivers. Shorthead redhorses are found in these rivers. Most of these are stream residents, but some fish may enter these streams from the lake (Moore, pers. comm. 1979). Shorthead redhorse runs tend to occur later than the sucker runs. In the Peshtigo River, shorthead redhorses spawn in early May at a water temperature below 52°F (Hawley 1967).

WM-4

East Twin (44°09', 87°34'), West Twin (44°09', 87°34'), and Manitowoc (44°05', 87°39') Rivers. Shorthead redhorses are found in these rivers (Belonger and Moore, pers. comm. 1979).

Michigan

MM-7

Port Sheldon (42°54', 86°13'). A few shorthead redhorses with moderate to well developed gonads were collected here in June; these fish may have been migrating into Pigeon Lake (42°54', 86°12') to spawn (Jude et al. 1979a).

GREATER REDHORSE

Wisconsin

WM-1

Pensaukee River (44°49', 87°54'). A minor spawning run enters the river (Imhof, pers. comm. 1979).

WM-4

West Twin River (44°09', 87°34'). Minor spawning runs enter the river (Imhof, pers. comm. 1979).

REDHORSE spp.

Michigan

MM-7

Muskegon River (43°15', 86°15'). Redhorses enter the river to spawn (Consumers Power 1976f).

White River (43°25', 86°21'). In 1969, many spawners were found in the river (GLFC 1970a,b).

BLACK BULLHEADS

Wisconsin

WM-1

Black bullheads are found along the western and southern shores of Green Bay (Belonger, pers. comm. 1979). It appears that they spawn in the sheltered bays and harbors, where they are normally found. They are also abundant year-round residents of Sawyer Harbor (44°53', 87°26') (Kernen 1972).

Illinois

Black bullheads probably reproduce in the harbors and bays along the Illinois shore (Muench, pers. comm. 1979).

Michigan

MM-7

Port Sheldon (42°54', 86°13). In 1978, one spent male black bullhead was collected in July in the area, suggesting that spawning occurred in June or July (Jude et al. 1979a).

CHANNEL CATFISH

Spawning runs enter tributaries (USDI 1966); the large rivers in the southeast portion of the lake, particularly the Grand River (43°03', 86°15'), probably serve as spawning and nursery areas (Wells, pers. comm. 1979). Limited spawning may occur in the lake proper (Jude, pers. comm. 1979; Wells, pers. comm. 1979).

Wisconsin

WM-1

Peaks Lake (44°34', 88°02')--Little Tail Point (44°40', 87°59'). Prior to 1920, Peaks Lake and the surrounding area north to Little Tail Point was one of the most heavily utilized spawning areas in Green Bay (Coberly and Horrall 1980b).

Fox River (44°32', 88°00')--Sable Point (44°35', 87°55'). Young-of-the-year (YOY) were collected in this area (Belonger, pers. comm. 1979).

Indiana

Michigan City (41°43', 86°54'). Channel catfish are present in the discharge canal of the Michigan City Generating Station (41°43', 86°54') during the spawning season (Morgan 1978c).

Michigan

MM-8

St. Joseph River (42°07', 86°29'). Spawning is believed to occur in the river (Jude, pers. comm. 1979).

Bridgman (41°56', 86°35'). A few YOY were taken at the Cook Power Plant (41°59', 86°34') (Jude, pers. comm. 1979).

BULLHEAD spp.

Wisconsin

WM-3

Rowley (45°13', 87°01'), North (45°09', 87°04'), and Moonlight (45°05', 87°05') Bays. Spawning occurs at the heads of North and Moonlight bays and in the marshy areas at the mouth of the Mink River (45°14', 87°02') (Frederick, pers. comm. 1979).

TROUT-PERCH

Trout-perch spawn along beaches in Lake Michigan during July and August; they may also spawn in tributaries. Young-of-the-year (YOY) inhabit inshore areas (Walburg 1973).

WM-1

Fox River (44°32', 88°00'). In 1975, eggs tentatively identified as those of trout-perch were entrained at the Pulliam Power Plant (44°32', 88°00') from May through July (CDM/Limnetics 1977; NALCO, undated a).

WM-5

Milwaukee (43°02', 87°54'). In 1972, ripe trout-perch were collected at McKinley Beach (43°03', 87°53'), over a sandy substrate on June 30 (Norden, pers. comm. 1979).

Oak Creek Harbor (42°51', 87°50'). A few ripe trout-perch were impinged at the Oak Creek Power Plant (42°54', 87°51') in June and August (Wis. Elec. Power 1976d).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Trout-perch spawn in this area (Commonw. Edison 1976). Ripe trout-perch, larvae, and YOY were collected here (Cochran, undated; LaJeone, pers. comm. 1979). In 1974, three trout-perch eggs were collected in the area; this suggests that spawning success is limited (Cochran and Cima 1974).

Indiana

Hammond (41°40', 87°30'). Trout-perch are believed to spawn successfully in the vicinity of the Stateline Generating Station (41°42', 87°31'). Peak impingement of adults occurred in July and August and coincided with the reported spawning time of this species. In 1975-76, eggs were entrained during late July and August; peak entrainment occurred in August. A few trout-perch larvae were collected in the lake near the plant; a few larvae were entrained on August 27 and September 5 (NALCO 1976c).

Gary (41°37', 87°20'). Trout-perch spawn in the vicinity of the Mitchell Power Station (41°37', 87°22'). In 1975, ripe trout-perch were most abundant during August, peak abundance of eggs occurred from July through September, and peak abundance of larvae occurred in August and September (NALCO 1976a). A few eggs were entrained from August to October. A few larvae less than 1 in. long were entrained from August to November; peak entrainment occurred in September (Krueger 1976).

Bailly Generating Station (41°39', 87°07'). Trout-perch eggs were entrained from April to October; larvae were entrained during February to December. The prolonged presence of eggs and postlarvae suggests that the spawning season may be extended by the warm water discharge (Tex. Instrum. 1976c).

Michigan City (41°43', 86°54'). The area extending from the Indiana Dunes (41°40', 87°02') to the Michigan state line (41°46', 86°49') is a nursery area for trout-perch; YOY were collected in this area, mostly west of Michigan City (McComish, pers. comm. 1979; Willis 1975). In 1979, YOY were collected in night tows at the 15 ft contour east and west of Michigan City in August (Koch, pers. comm. 1979). An offshore movement of adults is underway by October (McComish, pers. comm. 1979).

Michigan

MM-1

Bark River (45°34', 87°14'). In 1978, a few trout-perch eggs were found just north of the river mouth at the 30 ft contour (Wis. Elec. Power, unpubl. data).

Ford River (45°40', 87°08'). In 1978, small numbers of larvae were collected near the river mouth from mid-May to early August; peak abundance occurred on July 11 at the 5 ft depth contour (Wis. Elec. Power, unpubl. data).

Days River (45°54', 86°59'). In 1954 and 1955, 11,477 and 1,855 trout-perch, respectively, were collected at the FWS sea lamprey weir in the river in the spring (FWS 1979c); these catches suggest that a spawning run enters the river from the lake.

Fishdam River (45°54', 86°35'). In 1954, 50 trout-perch were collected at the FWS sea lamprey weir in the river in the spring (FWS 1979c); this catch suggests that a spawning run enters the river from the lake.

MM-3

Jordan River (45°09', 85°08'). Trout-perch appear as transients in the lower river in June and July (Quick 1971).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Trout-perch are commonly collected in trawls in this area. Ripe adults are found from late May to late August; peak spawning usually occurs from mid-June to mid-July. Larvae are present from early June through September. Young-of-the-year are seldom collected, but yearlings are abundant in the spring (Brazo, pers. comm. 1979).

MM-7

Grand Haven (43°04', 86°13'). In 1972, a few fry were collected in August within 3 ft of the surface off Grand Haven (Wells 1973).

Port Sheldon (42°54', 86°13'). An inshore migration of trout-perch occurs here in April and May; gonad data indicate that spawning occurs from April to September. In 1977 and 1978, ripe-running and spent adults and larvae were present from April to September (Jude et al. 1978, 1979a; Tin and Heufelder, pers. comm. 1979). Most spawning occurred from June through August; in 1977 and 1978, peak spawning occurred in June and August, respectively. By September most adults begin to migrate offshore. Fry about 0.8-1.6 in. long were first collected in trawls during September at depths of 30-50 ft. A few YOY were collected in October and November, but most had apparently moved out to deeper water for the winter (Jude et al. 1978, 1979b).

MM-8

Saugatuck (42°40', 86°12'). Collections of spent trout-perch in 1972 suggested that spawning occurred from late June or early July to late September (House and Wells 1973).

Palisades Power Plant (42°19', 86°19'). In 1972 and 1973, many trout-perch were impinged at the plant during the spawning season in April and June (Consumers Power 1975). In 1978, trout-perch were believed to have spawned in the nearshore waters from mid-July through mid-August. A few larvae were present from early August to late October (Wapora 1979c).

Bridgman (41°56', 86°35'). Spawning occurs in the area from the Cook Power Plant (41°59', 86°34') to Warren Dunes State Park (41°54', 86°37') from May to September. In 1973, the first major influx of adults occurred in the inshore waters in June. Spawning probably occurs from June to August; peak spawning occurred in July. Ripe adults were present from May through August; spent adults were present in increasing numbers from June through August. High inshore catches of trout-perch in July near the Cook Power Plant may have coincided with the peak spawning period (Jude et al. 1975, 1979b). Eggs and larvae were entrained at the plant (CDM/Limnetics 1977). Newly hatched larvae are collected in May and September (Jude, pers. comm. 1979); YOY are taken in seines and trawls beginning in July (Jude et al. 1975). In the fall, larvae and YOY are found in water about 20-30 ft deep; by November these fish have moved offshore (Jude, pers. comm. 1979; Jude et al. 1973, 1975, 1979b).

BURBOT

Wisconsin

Large numbers of adults are present in the fall and probably also in the winter in southern Green Bay (GLFC 1976c). Burbot probably spawn on most of the reefs in Green Bay under the ice in February (Moore, pers. comm. 1979).

WM-1

Youngs Reef (44°54', 87°42'). A commercial fisherman caught ripe burbot here under the ice in February (Coberly and Horrall 1980b).

Fox River (44°32', 88°00'). In 1975, eggs tentatively identified as those of burbot were entrained in April (NALCO, undated a). Larvae were entrained at the Pulliam Power Plant (44°32', 88°00') from late April to early June.

WM-2

Horseshoe Reefs (45°13', 87°12'). Extensive spawning occurs here under the ice; gill nets fished under the ice for whitefish catch large numbers of ripe burbot in January and February (Copes, Ebener, and Leary, pers. comm. 1979; Frederick, pers. comm. 1979).

Plum Island (45°19', 86°57'), Boyer Bluff (45°25', 86°56') and Deathdoor Bluff (45°18', 87°04'). Ripe-running burbot were caught through the ice here usually in February (Coberly and Horrall 1980b).

WM-4

Kewaunee Power Plant (44°21', 87°32'). In 1975, a few burbot larvae averaging about 0.2 in. long were entrained at the plant in April and May (LaJeone, pers. comm. 1979; NALCO, undated b).

WM-5

Haven (43°51', 87°44'). In 1974, larvae were collected here in April and May (LaJeone, pers. comm. 1979; Wis. Elec. Power et al. 1979b).

Sheboygan (43°45', 87°42'). In 1977-78, two burbot prolarvae were captured onshore near the Edgewater Generating Station (43°43', 87°42') on May 13 (Swanson Environ. 1979).

Port Washington (43°23', 87°52'). In 1979, one larva was entrained at the Port Washington Power Plant (43°23', 87°52') on April 28 (Wis. Elec. Power 1976e).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In 1973-77, a few burbot larvae were collected in this area from March to July (Cima 1977; Cima et al. 1976; Cochran and Cima 1974).

Michigan

MM-1

Whaleback Shoal (45°21', 87°11'). Gill nets fished under the ice for whitefish catch large numbers of ripe burbot in January and February (Frederick, pers. comm. 1979).

Bark River (45°34', 87°14')--Ford River (45°40', 87°08'). In 1977-78, burbot larvae were collected in shore seines near the Bark and Ford rivers during May 4-26. Larvae were found most consistently near the Ford River, however the greatest density occurred near the Bark River on May 18. Larvae were caught in the lake from April 25 to June 14; a maximum density of 24,500 per 1,000 m^3 occurred on May 11 at the 10 ft depth contour near the Bark River (Wis. Elec. Power, unpubl. data).

MM-3

Simmons Reef (45°55', 85°12') and Manitou Paymen Shoal (45°58', 85°04'). In the 1930s, spawning occurred in February and March on Simmons Reef and Manitou Paymen Shoal; both are rocky areas with water depths of about 30 ft (Organ et al. 1978).

MM-6

Ludington (43°57', 86°28'). Young-of-the-year burbot were found in tributaries of the Pere Marquette River (43°56', 86°26') (Brazo, pers. comm. 1979). Many larvae were collected along the 5 ft depth contour from Ludington to 2 mi S of the Ludington Pumped Storage Plant (43°54', 86°27') from late April through May (Brazo, pers. comm. 1979; Liston et al. 1978).

MM-7

Muskegon (43°13', 86°17'). In 1974-75, 840 burbot eggs were collected from water passing through the Cobb Power Plant (43°15', 86°15') on April 2-3; these eggs may have been released by impinged adults (Consumers Power 1976f).

Port Sheldon (42°54', 86°13'). Impingement of adults from January to April at the Campbell Power Plant (42°55', 86°12') and entrainment of eggs in January and of newly hatched larvae from February to June suggest that spawning may occur in the vicinity of the plant (Consumers Power 1976b; Heufelder, pers. comm. 1979; Jude 1978; Jude et al. 1979a). Burbot probably spawn nearshore from January to March and move to deeper water by April (Jude 1978). Newly hatched larvae are collected along shore; peak abundance occurs in April (Heufelder, pers. comm. 1979; Jude et al. 1979a). The capture of a male with well developed testes and the observation of larvae in Pigeon Lake (42°54', 86°12') suggest that Pigeon Lake may also be a spawning area for burbot (Jude 1978; Jude et al. 1978, 1979a).

MM-8

Palisades Power Plant (42°19', 86°19). In 1978, sampling 5 mi S of the plant revealed that eggs were present in low densities on April 15. Larvae were present at this site and at the plant from April 15 to May 15 (Wapora 1979c).

Bridgman (41°56', 86°35'). The collection of a few ripe-running burbot and eggs in December and January suggests that spawning occurs in the shallow inshore waters from the Cook Power Plant (41°59', 86°34') to Warren Dunes (41°54', 86°37') (Indiana and Mich. Power 1975, 1977; Jude, pers. comm. 1979; Jude et al. 1975, 1979b). Ripe adults were collected as late as April (Jude et al. 1979b). This area is also a nursery area; a few larvae were collected in April and May (Indiana and Mich. Power 1977; Jude, pers. comm. 1979; Jude et al. 1979b).

BROOK STICKLEBACK

Wisconsin

WM-5

Haven (43°51', 87°44'). A few ripe brook sticklebacks were collected in Lake Michigan here. It is suspected that these were migrants from Sevenmile Creek (43°51', 87°44') and the Pigeon River (43°47', 87°43'), where they are abundant (LaJeone, pers. comm. 1979).

Michigan

MM-3

Cross Village (45°39', 85°02'). In 1952, nests of brook sticklebacks were observed in the nearshore waters near Cross Village on July 6; the nests were attached to Scirpus and grass (Winn 1960).

Waugoshance Point (45°45', 85°01'). Nests and nesting fish were observed in an area (location unknown) near the point, over gravel among Scirpus; males were observed guarding these nests (Norden, pers. comm. 1979).

NINESPINE STICKLEBACK

Wisconsin

WM-4

Point Beach Power Plant (44°17', 87°32'). In 1975, a few ripe males and females were impinged at the plant from late May to the end of July (Wis. Elec. Power 1976c).

WM-5

Haven (43°51', 87°44'). In 1978, larvae were collected here in July and August; peak abundance occurred in July at the 30 ft depth contour (Wis. Elec. Power, unpubl. data).

Port Washington (43°23', 87°52'). In 1975, ripe adults were impinged at the Port Washington Power Plant (43°23', 87°52') from March to August; peak impingement occurred in late May and early June. A few larvae were entrained at the plant in late July and early August (Wis. Elec. Power 1976e). In 1978, larvae were collected at Port Washington; peak abundance occurred at the 30 ft depth contour in September (Wis. Elec. Power, unpubl. data).

Milwaukee (43°02', 87°54'). Ripe-running adults were collected in the McKinley Beach Marina (43°03', 87°53') area in 20 ft of water in July (Binkowski, pers. comm. 1979).

Oak Creek Harbor (42°51', 87°50'). In 1975, a few ripe adults were impinged at the Oak Creek Power Plant (42°51', 87°50') in May (Wis. Elec. Power 1976d).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Some ripe-running adults and larvae were collected in this area over sandy bottom with a few rocks (LaJeone, pers. comm. 1979). In 1972, half of the mature females collected in this area in June were ripe; one ripe female was collected at Waukegan in July (Cochran, undated). Spawning success in this area is limited (Cochran and Cima 1974); in 1973, only one larva was taken near Waukegan in 50 ft of water. In 1974-77, larvae were generally collected in the area from July to September; young-of-the-year were collected during August to October (Ind. Bio-Test 1975; Cima et al. 1976; Cima 1977).

Indiana

Hammond (41°40', 87°30'). Successful spawning is believed to occur in the vicinity of the Stateline Generating Station (41°42', 87°31'). In 1975, ninespine stickleback larvae were 0.3% of larvae collected in the lake and about 9% of those entrained at the plant; larvae were most abundant in nearshore areas (NALCO 1976c).

Michigan

MM-1

Bark River (45°34', 87°14'). In 1978, larvae were collected off the mouth of the river in July and August (Wis. Elec. Power, unpubl. data).

MM-5

Sleeping Bear Bay (44°55', 86°00'). In 1956, ninespine sticklebacks were observed nesting in the bay at depths of 50-60 ft in July. Nests were constructed of the alga Dichotomosiphon and located in small depressions on the bottom (Anderson 1967).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Ripe adults were collected in this area from mid-June to early July. Spawning may occur in coastal marshes. Larvae first appear in the area in mid-June, and peak concentrations are observed by late June; they appear to move to deeper water as they grow (Brazo, pers. comm. 1979).

MM-7

Port Sheldon (42°54', 86°13'). Gonad data suggest that sticklebacks spawn in the vicinity of the Campbell Power Plant (42°55', 86°12') in June and July; in 1977, many females caught in June and July had moderately to well developed ovaries (Jude et al. 1978). In 1978, ripe-running adults were collected in the area in April and May at water temperatures of about 47-63°F. After spawning in the shallows, adults may return to deeper water. In 1978, a few larvae were collected; spawning probably occurred in June and July (Jude et al. 1979a).

MM-8

Bridgman (41°56°, 86°35'). Gravid adults are fairly common in this area during April and May; however, the vegetation needed for spawning is not present in this area. Only one larva has been collected near the Cook Power Plant (41°59', 86°34') (Jude 1977, pers. comm. 1979; Jude et al. 1979b).

WHITE BASS

White bass migrate into small and medium-sized tributaries of Lake Michigan to spawn (Riggs 1952). They apparently reproduce now only in the Green Bay area.

Wisconsin

WM-1

Long Tail Point (44°35', 87°59')--Red Banks (44°37', 89°52'). Young-of-the-year (YOY) just over an inch long were captured along shore in the area from Long Tail Point to Red Banks in mid- to late June (Belonger, pers. comm. 1979). At Red Banks, YOY were found in an open, rocky area; at Duck Creek (44°34', 88°02'), YOY were collected in marshes. Spawning may occur in the areas where young were found (Belonger, pers. comm. 1979). According to commercial fishermen, the area from Little Tail Point (44°40', 87°59') to Peaks Lake (44°34', 88°02') was one of the most heavily used spawning areas until around 1920, when the marshes were filled (Coberly and Horrall 1980b). In 1975, a few larvae were collected in the Fox River (44°32', 88°00') and in Green Bay near the Pulliam Power Plant (44°32', 88°00') in early June (NALCO, undated a).

Illinois

Calumet River (41°44', 87°32'). Historically, white bass runs entered the river in June; runs sometimes moved as far upstream as Lake Calumet (41°41', 87°35') (Nelson 1878).

Michigan

MM-1

Whitefish River (45°55', 86°57'). In 1954, 50 white bass were caught at the FWS sea lamprey weir in the spring (FWS 1979c).

ROCK BASS

Illinois

Montrose Harbor (41°58', 87°38'), Belmont Harbor (41°57', 87°38'), Diversey Harbor (41°56', 87°38'), Lincoln Park Lagoon (41°55', 87°38'), Navy Pier (41°54', 87°36'), Burnham Harbor (41°51', 87°37'), 51st Street Harbor (41°48', 87°35'), Jackson Harbor (41°47', 87°35'), and Calumet Harbor (41°43', 87°31'). Spawning may occur in these areas (Muench, pers. comm. 1979).

Michigan

MM-3

Beaver Island (45°40', 85°33'). From 1970-77, rock bass spawned in the gravel shallows of Beaver Harbor (45°44', 85°30') in late June (Organ et al. 1978).

Garden Island (45°48', 85°30'). From 1970-77, spawning occurred on clay shallows (42°47', 85°30') on the west side of the island in late June (Organ et al. 1978).

Waugoshance Point (45°45', 85°01'). Rock bass spawn in nests used earlier in the season by smallmouth bass (Latta 1963).

GREEN SUNFISH

Illinois

Green sunfish may spawn in the harbors and lagoon areas along the Illinois shoreline (Muench, pers. comm. 1979).

PUMPKINSEED

Pumpkinseed probably do not spawn successfully in Lake Michigan proper; this species is usually found only near tributaries (CDM/Limnetics 1976c).

Wisconsin

WM-1

Sawyer Harbor (44°53', 87°26'). The pumpkinseed is a year-round resident and probably spawns here (Kernen, pers. comm. 1979).

Illinois

Trident Harbor (42°28', 87°48'). Young-of-the-year have been collected here (Muench, pers. comm. 1979).

Michigan

MM-7

Port Sheldon (42°54', 86°13'). In 1978, one ripe-running pumpkinseed was caught here in April. Young-of-the-year were collected here in July (Jude et al. 1979a).

BLUEGILL

Bluegills tend to spawn in harbors and tributaries rather than in Lake Michigan proper (CDM/Limnetics 1976c).

Illinois

Bluegills probably spawn in the harbor and lagoon areas along the Illinois shoreline (Muench, pers. comm. 1979).

Indiana

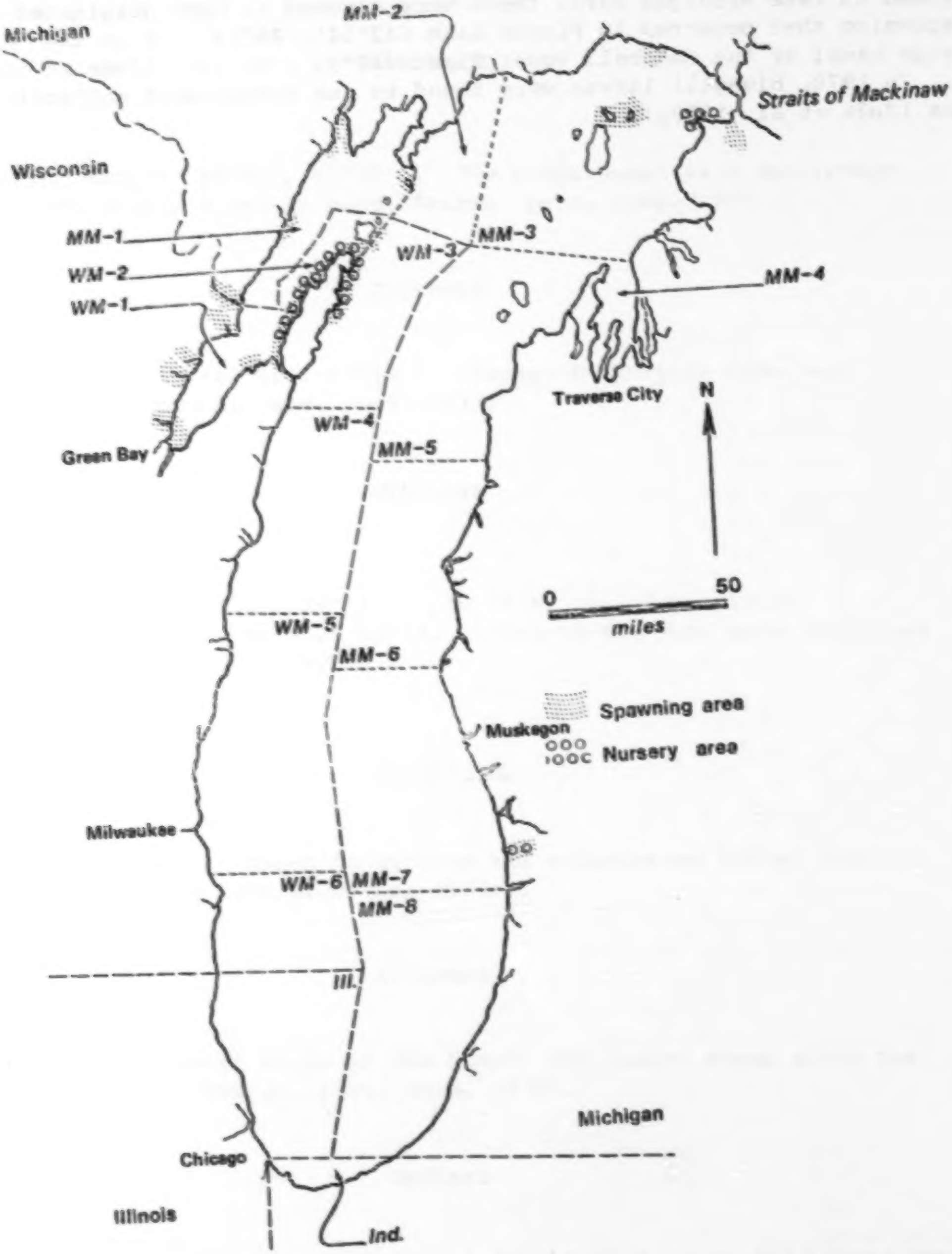
Michigan City (41°43', 86°54'). A few bluegill eggs and larvae were entrained at the Michigan City Generating Station (41°43', 86°54'); these probably originated from spawning that occurred in Trail Creek (41°44', 86°54') (Morgan 1978a).

Michigan

MM-7

Port Sheldon (42°54', 86°13'). A few larvae and young-of-the-year were found in Lake Michigan here; these were assumed to have originated from spawning that occurred in Pigeon Lake (42°54', 86°12') or in the discharge canal of the Campbell Power Plant (42°55', 86°12') (Jude et al. 1978). In 1978, bluegill larvae were found in one entrainment collection in June (Jude et al. 1979a).

SMALLMOUTH BASS


Michigan
MM-2
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
WM-4
MM-5
Green Bay
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

There are two major smallmouth bass spawning areas in Lake Michigan; these are the Green Bay-Door Peninsula area in Wisconsin and the Waugoshance Point area of Michigan.

Wisconsin

The protected areas of the Door Peninsula (45°05', 87°10') from Little Sturgeon Bay (44°50', 87°33') around to Baileys Harbor (45°03', 87°07') are spawning and nursery areas (Kernen, pers. comm. 1979). Smallmouth bass are not common in the waters south of Baileys Harbor which are not warmed by the outflow from Green Bay (Kernen, pers. comm. 1979).

WM-1

Menominee River (45°06', 87°35'), Oconto River (44°54', 87°50'), Peshtigo River (44°58', 87°39'), Pensaukee River (44°49', 87°54'), and Big Suamico River (44°38', 88°00'). Spawning runs enter these rivers (Kernen, pers. comm. 1979).

Peaks Lake (44°34', 88°02'). Before 1920, Peaks Lake and the surrounding area north to Little Tail Point (44°40', 87°59'), was heavily utilized by smallmouth bass for spawning (Coberly and Horrall 1980b).

Little Sturgeon Bay (44°50', 87°33'). Commercial fishermen report that spawning occurs here (Coberly and Horrall 1980b).

Sturgeon Bay (44°53', 87°24'). Fishermen report that spawning occurs in Sawyer Harbor (44°53', 87°26'), along the east shore (44°54', 87°23') of the bay (Coberly and Horrall 1980b), and in the Ship Canal (44°48', 87°19') (FWS 1979d).

WM-2

Sister Islands (45°13', 87°09'). Nests defended by males were observed in June and July on a substrate of sand and rock (Frederick, pers. comm. 1979).

Washington Island (45°23', 86°54'). Detroit Harbor (45°21', 86°55') is a smallmouth bass spawning area (Coberly and Horrall 1980b; Frederick, pers. comm. 1979; Leary and Ebener, pers. comm. 1979). Smallmouth bass also spawn in West Harbor (45°22', 86°57'), Jackson Harbor (45°24', 86°51'), and along shore between Jackson Harbor and Detroit Harbor (Coberly and Horrall 1980b).

WM-3

Rowley Bay (45°13', 87°01'). Adults were seen defending nests on a bottom of sand and rock at the head of the bay near the mouth of the Mink River (45°14', 87°02') (Frederick, pers. comm. 1979). The Mink River estuary has long been known as prime smallmouth bass spawning habitat (Daly 1974).

North Bay (45°09', 87°04'). Adults were seen here defending nests built on a rock and sand bottom (Frederick, pers. comm. 1979; Leary and Ebener, pers. comm. 1979).

Michigan

MM-1

Arthur Bay (45°19', 87°26'). Since the 1950s, smallmouth bass have spawned in an area (45°19', 87°25'--45°21', 87°24') just north of Arthur Bay; spawning occurs from mid-May through mid-June over rock in water 3-15 ft deep (Organ et al. 1978).

Little Bay de Noc (45°45', 87°00'). Smallmouth bass are believed to spawn in 2-20 ft of water along both shores of the bay over sand, gravel, rubble, and boulders (FWS 1979d).

Summer Islands (45°35', 86°40'). This island complex is probably a spawning area (Ebener, pers. comm. 1979).

MM-3

Beaver Island (45°40', 85°33'). In 1970-77, smallmouth bass spawned in Beaver Harbor (45°44', 85°30') over coarse gravel during the latter part of June (Organ et al. 1978).

Garden Island (45°48', 85°30'). In 1970-77, spawning occurred in the bay on the west shore (45°47', 85°30') over coarse gravel during the latter part of June. In 1972-76, spawning occurred along the southeast shore in early June (Organ et al. 1978).

Hog Island (45°47', 85°22'). In 1954, smallmouth bass spawned along the west shore of the island on gravel bottom during July; spawning also occurred along the east shore of the island over rock and gravel (Latta 1963; Organ et al. 1978).

Carp Lake River (45°45', 84°50'). In 1948-51, smallmouth bass entered the river to spawn; adults were captured as they migrated downstream (Applegate and Brynildson 1952).

Waugoshance Point (45°45', 85°01'). In 1954-55, smallmouth bass moved into the shallow areas at the point to spawn (Latta 1957). Nesting fish preferred areas in the protected back parts of shallow bays over gravel bottom in about 2 ft of water. Quiet water appeared to be a more important criterion governing nest site selection than substrate type or shelter (Latta 1957, 1963). Nesting usually began in early June when water temperatures rose above 60°F (Latta 1957, 1963). Eggs were found in the nests (Latta 1963), and larvae and fry were collected in the area (Latta 1957, 1963; Norden, pers. comm. 1979). From the 1930s to 1972, smallmouth bass spawned on rock and silt on both the north and south sides of Waugoshance Point and Waugoshance Island (45°46', 85°04'). Spawning occurred as late as June or early July in water 3-4 ft deep (Organ et al. 1978).

MM-7

Port Sheldon (42°54', 86°13'). Smallmouth bass from Pigeon Lake (42°54', 86°12') or the nearshore waters of Lake Michigan may enter the Pigeon River (42°54', 86°12') to spawn. In 1978, smallmouth bass larvae were collected in Pigeon Lake; young-of-the-year about 3-4 in. long were impinged at the Campbell Power Plant (42°55', 86°12') (Jude et al. 1979b).

LARGEMOUTH BASS

Illinois

Trident Harbor (42°28', 87°48'), Waukegan Generating Station Lagoon (42°23', 87°49'), Waukegan Harbor (42°22', 87°49'), Great Lakes Naval Harbor (42°18, 87°50'), Wilmette Harbor (42°05', 87°41'), Northwestern University Lagoon (42°03', 87°40'), Montrose Harbor (41°58', 87°38'), Belmont Harbor (41°57', 87°38'), Diversey Harbor (41°56', 87°38'), Lincoln Park Lagoon (41°55', 87°38'), Navy Pier (41°54', 87°36'), Burnham Harbor (41°51', 87°37'), 51st Street Harbor (41°48', 87°35'), Jackson Harbor (41°47', 87°35'), and Calumet Harbor (41°43', 87°31'). Young-of-the-year were collected here, and reproduction probably occurs in these areas (Muench, pers. comm. 1979).

Michigan

MM-1

Arthur Bay (45°19', 87°26'). Largemouth bass spawn in an area (45°19', 87°25'--45°21', 87°24') north of Arthur Bay; spawning occurred over rock in 3-15 ft of water from mid-May to mid-June (Organ et al. 1978).

MM-3

Point Epoufette (46°03', 85°12'). Largemouth bass spawn over mud and weeds on both sides of the point in mid-May (Organ et al. 1978).

MM-7

Port Sheldon (42°54', 86°13'). In 1978, larvae and spawning concentrations of adults were observed in Pigeon Lake (42°54', 86°12') near the Campbell Power Plant (42°55', 86°12'). Larvae were entrained at the plant in early June. Young-of-the-year largemouth bass were collected in seines from July to September (Jude et al. 1979a).

BASS spp.

Illinois

Calumet River (41°44', 87°32'). In the late 1870s, black bass were seined as they ran into the river during spring and summer (Nelson 1878); this may have been a spawning run.

WHITE CRAPPIE

It is unlikely that white crappie spawn successfully in Lake Michigan proper (CDM/Limnetics 1976c).

Illinois

Montrose Harbor (41°58', 87°38'), Belmont Harbor (41°57', 87°38'), Diversey Harbor (41°56', 87°38'), Lincoln Park Lagoon (41°55', 87°38'), Navy Pier (41°54', 87°36'), Burnham Harbor (41°51', 87°37'), 51st Street Harbor (41°48', 87°35'), Jackson Harbor (41°47', 87°35'), and Calumet Harbor (41°43', 87°31'). These may be spawning areas (Muench, pers. comm. 1979).

BLACK CRAPPIE

It is unlikely that black crappie spawn in Lake Michigan proper (CDM/Limnetics 1976c).

Illinois

Montrose Harbor (41°58', 87°38'), Belmont Harbor (41°57', 87°38'), Diversey Harbor (41°56', 87°38'), Lincoln Park Lagoon (41°55', 87°38'), Navy Pier (41°54', 87°36'), Burnham Harbor (41°51', 87°37'), 51st Street Harbor (41°48', 87°35'), Jackson Harbor (41°47', 87°35'), and Calumet Harbor (41°43', 87°31'). These may be spawning areas (Muench, pers. comm. 1979).

CRAPPIE spp.

Michigan

MM-7

Port Sheldon (42°54', 86°13'). In 1978, larvae were entrained at the Campbell Power Plant (42°55', 86°12') from late May through the first week of August at water temperatures of about 58-68°F. A small population of crappie may inhabit and spawn in the intake canal of the plant. A few larvae were captured in Pigeon Lake (42°54', 86°12') in June (Jude et al. 1979a).

JOHNNY DARTER

Indiana

Hammond (41°40', 87°30'). Successful spawning is believed to occur in the vicinity of the Stateline Generating Station (41°42', 87°31'). In 1975-76, johnny darter larvae were common in the area in June and July (NALCO 1976c).

Michigan City (41°43', 86°54'). Young-of-the-year (YOY) were collected west of Michigan City on clay mounds off Kintzele Ditch (41°43', 86°56') (Palacios, pers. comm. 1979).

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Spawning occurs in this area (Brazo, pers. comm. 1979). In 1979, ripe adults were collected in an area (43°55', 86°26') about 2 mi S of the plant in mid-June to mid-July, over sand, in water 5-15 ft deep; eggs and larvae were also collected. Larvae were found here and 1/2 mile S of the plant over large rocks and clay outcroppings (Brazo, pers. comm. 1979; Liston et al. 1978).

MM-7

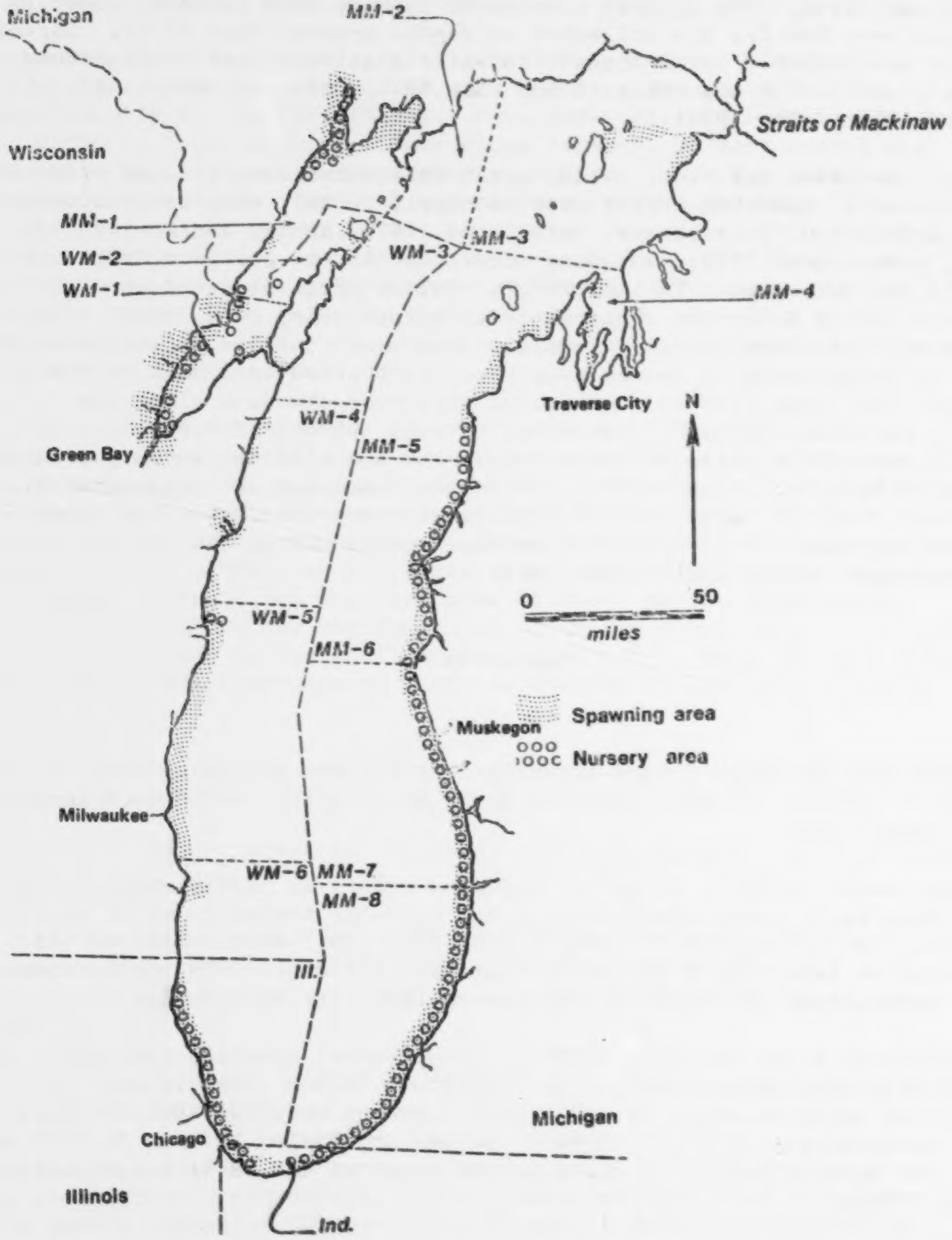
Port Sheldon (42°54', 86°13'). Johnny darters move inshore in this area to spawn. In 1978, running-ripe females and one spent male were collected during June (Jude et al. 1979a). Gonad data suggest that spawning occurred in June and July in Lake Michigan and from late April to mid-May in Pigeon Lake (42°54', 86°12'). Larvae were caught at beach stations near the Campbell Power Plant (42°55', 86°12') during June (Jude et al. 1978); larvae were collected from Pigeon Lake and were entrained at the plant (Heufelder, pers. comm. 1979). After spawning, adults may move to a sand or gravel substrate in deeper water (Jude et al. 1978, 1979a).

MM-8

Palisades Power Plant (42°19', 86°19'). In 1978, spawning occurred in the vicinity of the plant from mid-July to mid-August. Eggs were collected on August 4 in an area (42°15', 86°21') 5 mi S of the power plant. Larvae were collected in the area from early August to late October. Larvae were also entrained at the plant (Wapora 1979c).

Bridgman (41°56', 86°35'). Spawning occurs near the Cook Power Plant (41°59', 86°34') (Jude 1977; Jude, pers. comm. 1979; Jude et al. 1975, 1979b). Catches of ripe-running adults suggest that spawning occurs during May and June (Jude et al. 1975, 1979b). Eggs were collected from the riprap around the intake structure. The area near the plant at the 20-30 ft depth contours is a nursery area. The Warren Dunes area (41°54', 86°37') may also be a nursery ground (Jude, pers. comm. 1979).

YELLOW PERCH


Michigan
MM-2
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
WM-4
MM-5
Green Bay
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

In Lake Michigan, most yellow perch spawning areas are located in Green Bay (45°05', 87°25') and along the east and south shores of the lake proper. Yellow perch spawn from about mid-May to July 1, when water temperatures are 49-62°F. In the southern two-thirds of the lake, spawning usually occurs in May and June. Most spawning apparently occurs among weeds or on rocky shoals; these areas provide substrate to which egg masses can cling. The largest catches of fry are made in water about 16 ft deep; very few fry are collected at depths greater than 33 ft. Larvae and fry are probably most abundant in water shallower than 20 ft (Brown and Wells 1976; CDM/Limnetics 1976c; GLFL 1970; Hile and Jobes 1942; Walburg 1973; Wells 1974).

In the Green Bay area, yellow perch runs enter many streams after the ice goes out. Spawning occurs from mid-April to May, when temperatures reach about 47-50°F (Belonger, pers. comm. 1979; Kernen and Hawley 1978; Sager, pers. comm. 1979); spawning occurs earlier in southern Green Bay than in the lake proper (Wells 1977a). Yellow perch migrated into the southern end of Green Bay, apparently to spawn (Hile, pers. comm. 1979). Commercial fishermen recently reported that small numbers of yellow perch could be found spawning nearly everywhere in the southern half of the bay, but that ripe fish and egg masses were most abundant along the western shore of the bay (Coberly and Horrall 1980b). The marshy shorelines in some parts of Green Bay may be spawning and nursery grounds (Wells 1977a, pers. comm. 1979). Fishermen contended and tagging studies confirmed that the larger yellow perch that spawned in Green Bay tended to move northward after spawning, perhaps moving out of the bay and into Lake Michigan proper (Hile 1953b; Mraz 1952).

Wisconsin

WM-1

Spawning probably occurs along the entire open shoreline from Marinette (45°05', 87°36') south to Green Bay (44°30', 88°00') (Belonger, pers. comm. 1979).

Marinette (45°05', 87°36'). Spawning occurs in marshy areas and off piers from early April through early May at water temperatures of about 50-52°F. In 1977 and 1978, young-of-the-year (YOY) were collected off Marinette in late August and early September (Belonger 1979, pers. comm. 1979; Belonger et al. 1979; Kernen and Hawley 1978; USDI 1966).

Peshtigo River (44°58', 87°39'). Substantial spawning runs enter the river (Belonger, pers comm. 1979). The mouth of the river is an historical spawning area; in 1977, peak spawning occurred April 7-14 at water temperatures of about 43-50°F (Kernen and Hawley 1978). In 1977 and 1978, YOY were collected in the area (Belonger et al. 1979; Kernen and Hawley 1978).

Oconto River (44°54', 87°50'). Substantial spawning runs enter the river (Belonger, pers. comm. 1979). In 1977 and 1978, YOY were collected in the area (Belonger 1979; Belonger et al. 1979; Kernen and Hawley 1978).

Pensaukee River (44°49, 87°54'). A run enters the river, and spawning occurs in mid-April at water temperatures of about 46-55°F (Belonger, pers. comm. 1979; Kernen and Hawley 1978). In 1977, YOY were collected here (Kernen and Hawley 1978).

Little Suamico River (44°42', 87°59'). A spawning run probably enters the river (Sager, pers. comm. 1979).

Peaks Lake (44°34', 88°02')--Little Tail Point (44°40', 87°59'). Before 1920, this area was one of the most heavily used spawning areas in Green Bay (Coberly and Horrall 1980b). Runs enter the Big Suamico River (44°38', 88°00'), Peaks Lake, and Duck Creek (44°34', 88°02') around the second week in April at water temperatures of about 46-57°F. Runs may begin before ice breakup. Spawning also occurs inside Long Tail (44°35', 87°59') and Little Tail points. This is a major nursery area; the highest densities of YOY are found inside Long Tail Point (Belonger 1979, pers. comm. 1979; Belonger et al. 1979; Kernen and Hawley 1978; Sager, pers. comm. 1979). It has been proposed that the area from Long Tail Point to the Fox River (44°32', 88°00') be designated as "reserve water" to enhance yellow perch reproduction (Daly 1977).

Fox River (44°32', 88°00'). Spawning runs enter the Fox River (Belonger, pers. comm. 1979). Pre-spawning concentrations of males are present in late March (Kernen and Hawley 1978). Spawning occurs from late April through the first 2 weeks of May at water temperatures of about 50-66°F (Kernen and Hawley 1978; Sager, pers. comm. 1979). At the Pulliam Power Plant (44°32, 88°00') on the lower river, yellow perch move inshore in April, spawn in April and May, and move offshore as the water warms. Larvae were collected in May and June, and young may spend their first and possibly second winter in the shallows near the plant. Many YOY have been impinged at the plant; impingement peaks in October (NALCO 1977, undated a).

Bay Beach Park (44°32', 87°59'). Spawning occurs east of the park (Sager, pers. comm. 1979).

Red River (44°40', 87°45'). In 1977, YOY were collected in this area (Kernen and Hawley 1978).

Little Sturgeon Bay (44°50', 87°33'). Fishermen report this is a spawning area (Coberly and Horrall 1980b). In the late 1970s, YOY were collected here (Belonger et al. 1979; Kernen and Hawley 1978; Sager, pers. comm. 1980).

Larsens Reef (44°53', 87°29'). This is an historical spawning ground (Horrall, pers. comm. 1979).

Sturgeon Bay (44°53', 87°24'). Sawyer Harbor (44°53', 87°26') is a spawning area (Coberly and Horrall 1980b); spawning most likely occurs along the marshy shoreline (Kernen 1972). Spent females are present in the area as early as May 3 at water temperatures of about 52°F; cool temperatures may extend spawning into late May (Kernen and Hawley 1978).

Spawning also occurs along the east shore (44°54', 87°23') of Sturgeon Bay (Coberly and Horrall 1980b) and in the Ship Canal (44°48', 87°19') (FWS 1979d).

WM-2

Chambers Island (45°11', 87°21'). Larvae were collected along the south shore of the island from late April to early May (Frederick, pers. comm. 1979).

Washington Island (45°23', 86°54'). Commercial fishermen have identified West Harbor (45°22', 86°57'), Jackson Harbor (45°24', 86°51'), Detroit Harbor (45°21', 86°55'), and the east shore of the island as spawning areas (Coberly and Horrall 1980b).

Europe Bay (45°16', 86°59'). This is a spawning area (Coberly and Horrall 1980b).

WM-4

Algoma (44°37', 87°26'). Fishermen report that the harbor is a spawning area (Coberly and Horrall 1980b).

Kewaunee (44°27', 87°30'). Kewaunee Harbor is a spawning area (Coberly and Horrall 1980b).

Kewaunee Power Plant (44°21', 87°32'). A few ripe-running and spent adults were collected in the area at depths of 12-20 ft in May and June at temperatures of about 44-50°F. In the 1970s, a few eggs and larvae were collected near the plant; no YOY were collected in the area (LaJeone, pers. comm. 1979; LaJeone 1976).

Point Beach Power Plant (44°17', 87°32'). Little successful spawning occurs in this area (Wis. Elec. Power 1975a; Wis. Elec. Power and Wis.-Mich. Power 1970, undated a); however, adults migrated inshore here in large numbers in April and May and remained until September (Wis. Elec. Power and Wis.-Mich. Power, undated a).

Two Rivers (44°09', 87°34'). In 1979, a spawning run entered the West Twin River in the spring (Hanson, pers. comm. 1979). Two Rivers Harbor is also a spawning area (Coberly and Horrall 1980b).

WM-5

Pine Creek (43°59', 87°42')--Oak Creek Harbor (42°51', 87°50'). Yellow perch spawn here to depths of about 30 ft (Coberly and Horrall 1980b).

Haven (43°51', 87°44'). Ripe-running adults were collected in May and June throughout the area along the shoreline at the 20-30 ft contour. No eggs were collected, but larvae were taken in July, indicating that successful spawning may have occurred in June. Substrate in the area is generally small rocks, cobble, and boulders over a hard clay bottom (Ind. Bio-Test 1977; Wis. Elec. Power 1975c; Wis. Elec. Power et al. 1979a,b).

Milwaukee (43°02', 87°54'). Historically, yellow perch fry were preyed upon by lake trout near the piers at Milwaukee (Poff and Threinen 1964). Large numbers of yellow perch move into shallow water here in June (Shaefer 1975). Ripe adults were collected along shore and in water 30 ft deep from mid-June through the end of July (Binkowski, pers. comm. 1979; Norden, pers. comm. 1980; Shaefer 1975). Adults remained in water about 30 ft deep from June to September (Shaefer 1975).

WM-6

Racine Reef (42°44', 87°45') and Kenosha Harbor (42°35', 87°49'). A commercial fisherman reported that spawning occurs here (Coberly and Horrall 1980b).

Illinois

Reproduction and recruitment of yellow perch in Illinois waters of Lake Michigan has not been measured but is probably less than that occurring along the east and southeast shores of the lake (Muench 1979). Eggs, larvae, and YOY are found along the Illinois shoreline; however, during the 1970s, YOY were abundant only in 1979 (Muench, pers. comm. 1979). Spawning occurs in early June, probably in water shallower than 42 ft (Muench 1979). Limited substrate suitable for spawning is present in harbors and lagoons and on the shallow bedrock platform extending south from the Great Lakes Naval Training Center (42°18', 87°50') (Muench 1979, pers. comm. 1979; Norby and Collinson 1977).

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Limited spawning occurs in this area (Cochran, undated). Ripe-running males and females were found in June and July, and a few larvae and YOY were collected (Cima 1977; Cima et al. 1976; Cochran, undated; Cochran and Cima 1974; Commonw. Edison 1976; Ind. Bio-Test 1975; Muench 1979).

Evanston (42°03', 87°40'). In 1980, eggs were found off Evanston in early June, at depths of 20 and 27 ft on rocky substrate (Janssen, pers. comm. 1980).

Indiana

Yellow perch probably spawn along the entire Indiana shoreline during late May and early June, but areas of concentration exist (McComish, pers. comm. 1979). Ripe and spawning adults have been collected along the Indiana shoreline from late May through August; peak abundance occurs in May and June at depths of 60-70 ft (Koch, pers. comm. 1979; McComish, pers. comm. 1979; Westerman, pers. comm. 1979; Willis 1975).

Hammond (41°40', 87°30'). Yellow perch spawned in Indiana Harbor (41°40', 87°25') in the area now being filled by the Inland Steel Company

(Palacios, pers. comm. 1979). Yellow perch are still believed to spawn successfully in the vicinity of the Stateline Generating Station (41°42', 87°31'); however, only a few eggs and larvae were collected (NALCO 1976c).

Bailly Generating Station (41°39', 87°07'). Adults are present in May and June, and spawning appears to occur in this area in June or July. Larvae are entrained at the plant in June, and YOY are collected in beach seines in August (Tex. Instrum. 1975b, 1976a,c).

Michigan City (41°43', 86°54'). The rough-bottomed area (41°42', 86°57') just west of Michigan City is an important spawning ground (McComish, pers. comm. 1979; Wells 1980). In 1966, ripe, partly spent, and spent adults were collected here in late May (GLFL, unpubl. data), and running-ripe males have recently been found over the clay mounds off Kintzele Ditch (41°43', 86°56') (Palacios, pers. comm. 1979). Spawning adults are present in the area into July (Willis 1975). Adults move offshore to deeper water by August (McComish, pers. comm. 1979; Willis 1975). Spawning is believed to occur over the crevice and drop-off areas where the substrate is hard-packed sand, clay, and shale (McComish, pers. comm. 1979). Eggs were found here on fishermen's nets (Palacios, pers. comm. 1979). The area west of Michigan City is also an important nursery area; YOY are collected inshore beginning in August and are more abundant here than east of Michigan City. Most YOY move to deeper water by October (Koch, pers. comm. 1979; McComish, pers. comm. 1979; Palacios, pers. comm. 1979; Willis 1975; Yager and McComish 1976).

Michigan

The shoreline from New Buffalo (41°48', 86°45') to Frankfort (44°38', 86°15'), in all areas shallower than 30 ft, is probably a nursery ground for yellow perch (Wells 1972, 1973).

MM-1

Arthur Bay (45°19', 87°26'). Since the 1950s, spawning has occurred in an area (45°17', 87°27'--45°20', 87°25') of sand and rock in about 30 ft of water (Organ et al. 1978).

Ford River (45°40', 87°08')--Bark River (45°34', 87°14'). In 1978, larvae were collected along shore in May and June; they were most abundant (3,234 per 1,000 m^3) in early June near the mouth of the Bark River (Wis. Elec. Power, unpubl. data).

Little Bay de Noc (45°45', 87°00') and Big Bay de Noc (45°45', 86°45'). Little Bay de Noc and Big Bay de Noc are major spawning areas (Copes and Leary, pers. comm. 1979). Yellow perch spawn successfully in many small, marshy tributaries along the west shore of Little Bay de Noc (FWS 1979d). Fry are first present in Little Bay de Noc in late April or early May (Peck 1974).

Portage Point (45°42', 87°04'). Yellow perch spawn in the large wetland here (FWS 1979d).

Whitefish River (45°55', 86°57'). Large numbers of yellow perch spawned in the lower iver r (Jenkins 1972; Wagner 1972). In 1965, spawning occurred just north of Nelson's Landing (45°54', 86°59') over sand, rock, and rubble (Wagner 1968).

Saunders Point (45°51', 87°00')--Stonington (45°45', 86°59'). Until 1940, yellow perch spawned along shore over shoal areas of sand and rock (Organ et al. 1978).

Ogontz Bay (45°50', 86°45'). Until the 1940s, spawning occurred in the bay over sand and rock at depths of 12-24 ft (Organ et al. 1978).

Valentine Point (45°51', 86°32')--Stony Point (45°50', 86°39'). Until the 1940s, yellow perch spawned in this area at depths of 6-12 ft over sand and gravel (Organ et al. 1978).

MM-3

Beaver Island (45°40', 85°33'). Since the 1920s, yellow perch have spawned over rock and gravel in Beaver Harbor (45°44', 85°30') and over rock just outside the harbor (Organ et al. 1978).

Hog Island (45°47', 85°22')--Grays Reef Passage (45°47', 85°09'). Spawning occurred here on rock and gravel shoals (Organ et al. 1978).

Point Epoufette (46°03', 85°12'). Spawning occurs nearshore over mud and vegetation in areas immediately east (46°04', 85°11') and west (46°03', 85°12') of Point Epoufette (Organ et al. 1978).

Waugoshance Point (45°45', 85°01')--Good Hart (45°34', 85°07'). From the 1930s to 1972, spawning occurred along the shoreline north of Cross Village (45°39', 85°02') to a depth of about 30 ft, over sand and gravel; spawning also occurred south of Cross Village over an unknown substrate (Organ et al. 1978).

MM-4

Grand Traverse Bay (45°05', 85°30'). The wetlands in the bay are extremely important spawning grounds (FWS 1979d).

Bowers Harbor (44°53', 85°33'). From 1935-40, yellow perch spawned over rock and gravel in the outer part of the harbor, along the west side of Marion Island (44°52', 85°35'), and in an area (44°55', 83°33') extending about 2 mi along the north side of Tucker Point (44°54', 85°34') (Organ et al. 1978).

New Mission Point (45°03', 85°34'). From 1935-40, spawning ocurred in an area (45°04', 85°34'--45°00', 85°38') to a depth of about 30 ft over rock, gravel, and moss (Organ et al. 1978).

Northport Point (45°08', 85°33'). From 1935-40, spawning occurred along the east side of the point to depths of about 40 ft, over rock and gravel (Organ et al. 1978).

MM-5

Leland (45°01, 85°46'). From the 1900s to 1968, spawning occurred along the shoreline extending about 3 mi N from Leland, at depths of about 18-20 ft over rock (Organ et al. 1978).

Pyramid Point Shoal (44°59', 85°55'). Spawning occurs on the shoal over sand and rock (Organ et al. 1978).

Empire (44°49', 86°04')--Sleeping Bear Point (44°55', 86°03'). Spawning occurs along this shoreline over rock and gravel (Organ et al. 1978).

Platte River (44°44', 86°09'). Spawning occurs over the rocky reef at the mouth of the Platte River (Organ et al. 1978).

Frankfort (44°38', 86°14'). Yellow perch spawn along the shore, from Frankfort south to the Arcadia area (44°30', 86°14') (Hile, pers. comm. 1979). Spawning occurs directly off Frankfort to a depth of about 30 ft (Organ et al. 1978). In 1972, yellow perch fry were collected off Frankfort in late July from the surface to about the 12 ft depth stratum above the 18 and 30 ft depth contour (Wells 1973).

MM-6

Big Sable Point (44°03', 86°31')--Manistee (44°15', 86°20'). From the 1930s to 1965, spawning occurred along this shoreline over gravel (Organ et al. 1978).

Ludington (43°57', 86°28')--Little Sable Point (43°39', 86°33'). From the 1930s to 1965, yellow perch spawned all along the shoreline from about 5 mi N (44°01', 86°30') of Ludington, to Little Sable Point, to a depth of 36 ft, over rock and gravel (Organ et al. 1978). In the vicinity of the Ludington Pumped Storage Plant (43°54', 86°27') spawning takes place from mid-May through June; peak spawning occurs in the third week of June at water temperatures of about 50°F. Large numbers of yellow perch move into the area usually during late April to late May at water temperatures of about 36-39°F. Ripe males appear at depths of approximately 18-36 ft, when the water temperature reaches about 43-45°F (Brazo et al. 1977; Liston and Tack 1972). Ripe males have appeared as early as April in some years, and some are still ripe in late July; all females are usually spent by July (Brazo 1973, pers. comm. 1979; Liston and Tack 1973). Most eggs have hatched by the end of July (Liston and Tack 1973). Yellow perch may spawn here at depths of less than 40 ft (Liston and Tack 1973); adults are collected here in water as shallow as 5-10 ft (Brazo, pers. comm. 1979). Egg masses were collected here with trawls (Liston and Tack 1972). Spawning concentrations were observed a few miles south of the plant (Liston and Tack 1972); these fish may spawn over rock piles near the breakwater jetties of the plant (Brazo, pers.

comm. 1979). Spawning occurs just south of the plant's south breakwater (FWS 1979d). Larvae were collected in shallow water near the plant and south of the plant from mid- to late May (Brazo, pers. comm. 1979; Liston et al. 1978).

MM-7

Stony Lake (43°34', 86°30')--Little Point Sable (43°39', 86°33'). In 1944-55, spawners were caught in an area from 3 mi S of Stony Lake to Little Point Sable, over sand to a depth of about 40 ft (Organ et al. 1978).

White Lake (43°23', 86°26')--Grand Haven (43°04', 86°13'). From the 1930s to the 1970s, spawning occurred along the shoreline, from just north of White Lake, to Grand Haven, to a depth of about 70 ft over a sand bottom (Organ et al. 1978).

Grand Haven (43°04', 86°13')--Holland (42°47', 86°07'). From the 1930s to 1975, spawning occurred along this entire shoreline to depths of about 70 ft over sand (Organ et al. 1978). Ripe-running adults move inshore at Port Sheldon (42°54', 86°13') in June when water temperatures are about 45-53°F (Heufelder, pers. comm. 1979; Jude et al. 1978); ripe-running adults were also impinged at the Campbell Power Plant (42°55', 86°12') in May (Jude 1978). Eggs were collected in Pigeon Lake (42°54', 86°12') and larvae were entrained at the plant and collected in the area in April; this indicates that spawning occurred in Pigeon Lake in April (Jude 1978). One group of yellow perch from Lake Michigan probably spawns in Pigeon Lake in late April to early May; a second group probably spawns in Lake Michigan in the vicinity of the plant in late May to early June (Jude et al. 1979a). Larvae were entrained at the plant and collected in the lake in the vicinity of the plant in May and June. By early or late June, yellow perch larvae are very abundant in Lake Michigan at depths of about 20-40 ft (Consumers Power 1977; Jude et al. 1978, 1979a; Wapora 1979a). Young-of-the-year were collected in beach seines in June to August (Heufelder, pers. comm. 1979; Jude et al. 1978, 1979a).

MM-8

Holland (42°47', 86°07')--Saugatuck (42°40', 86°12'). Since 1930, spawning has occurred along this entire shoreline over sand, rock, and gravel (Organ et al. 1978).

Saugatuck (42°40', 86°12')--South Haven (42°24', 86°17'). Since the 1940s, spawning has occurred along this shoreline to depths of 50-60 ft over clay, sand, and rock (Organ et al. 1978). In the Saugatuck area, yellow perch appear to favor rocky areas for spawning. During the spawning season, catches of adults in this area on sandy bottom are only about one fifth as large as catches over rocky bottom (Harris and Eschmeyer 1975). In 1971, large numbers of males in spawning condition were present on the reef (42°38', 86°17') off Saugatuck in late May. Females in spawning condition were present in fair numbers in mid-June (Tait 1973). This reef, known as "Honey Comb Reef" before the turn of the century, is made up of boulders and extends from shore to depths of about

72 ft (Wells 1972); this reef is now probably a major spawning area (Dorr, pers. comm. 1979; Wells 1972). Commercial fishermen report that spawning occurred here from 1934-77 (Organ et al. 1978). In 1973, fry were found off Saugatuck in May, but it is believed that these originated from spawning that occurred in tributaries (Harris and Eschmeyer 1975). In 1974, trawl catches of YOY were moderate in the Saugatuck area (Brown and Wells 1975).

South Haven (42°24', 86°17')--Benton Harbor (42°06', 86°27'). Since the 1930s and 1940s, spawning has occurred over sand and rock along most of this shoreline (Organ et al. 1978). Yellow perch is one of the principal species that spawns nearshore in the vicinity of the Palisades Power Plant (42°19', 86°19') (Consumers Power 1972b, 1975). Yellow perch generally move into the shallows in mid-May and June to spawn, as evidenced by increased catches and impingement of ripe adults at that time (Consumers Power 1972b, 1975; Patriarche 1969, 1971a, 1975; Wapora 1979c,d). In 1973, many yellow perch that had already spawned were captured in early May suggesting that spawning had occurred 3-4 weeks earlier than normal; this early spawning was attributed to early warming of the water by the power plant discharge (Consumers Power 1973b, 1975; Patriarche 1973b, 1974, 1975). In 1972 and 1974, eggs thought to be yellow perch were found at the intake during June (Consumers Power 1972b, 1976g; Patriarche 1972). In 1978, yellow perch larvae less than 0.5 in. long were collected in the area; the abundance of larvae peaked in late June (Wapora 1979c). Yellow perch fry were collected near the plant at depths to 30 ft (Consumers Power 1975; Wells 1974). Young-of-the-year yellow perch were collected in seines in August and September (Consumers Power 1975; Patriarche 1974, 1975; Wapora 1979d).

Benton Harbor (42°06', 86°27')--St. Joseph (42°06', 86°29'). In the past, yellow perch spawning runs entered the shallow waters near Benton Harbor and St. Joseph (Brazo et al. 1977). In 1969, several hundred YOY were collected off Benton Harbor; however, only a few were collected in similar sampling in other years during the period 1967-75 (Wells 1977a). A small area called Rocky Gap (42°08', 86°28'), north of Benton Harbor, is a potential spawning area for yellow perch (Dorr, pers. comm. 1979).

Stevensville (42°01', 86°33'). Viable eggs were observed on clay rubble here (Dorr, pers. comm. 1979).

Bridgman (41°56', 86°35'). Limited spawning occurs in the area from the Cook Power Plant (41°59', 86°34') to Warren Dunes (41°54', 86°37') during late May and June at water temperatures of 45-59°F. A few gravid adults were collected, and a few eggs were collected in nets and observed on the riprap of the intake structure of the power plant. In 1973-74, almost 90% of the adults collected in June were spent; most spawning was believed to occur outside the immediate area (Dorr, pers. comm. 1979; Indiana and Mich. Power 1975; Jude 1976a; Jude et al. 1973, 1975, 1979b). From 1959-69, yellow perch spawned in an area (41°57', 86°36') off Bridgman, over sand and clay at depths of 25-50 ft (Organ et al. 1978). The shoreline from the power plant to Warren Dunes is a nursery area (Jude and Tesar, pers. comm. 1979). Larvae less than 0.5 in. long first appear in the nearshore waters in June, and many YOY are collected from July through October (Indiana and Mich. Power Co. 1975; Jude, pers. comm. 1979; Jude et al. 1973, 1975, 1979b).

New Buffalo (41°48', 86°45'). In 1945-68 spawning occurred along the sand-bottomed shoreline from Warren Dunes (41°54', 86°37') to the Indiana state line (41°46', 86°49') at depths to 50-60 ft. Since 1916, spawning has occurred to depths of about 12 ft on a rocky area between Union Pier (41°50', 86°42') and Lakeside (41°51', 86°40'). Spawning also occurs on Bridgman Reef (41°52', 86°42') over clay (Organ et al. 1978).

SAUGER

In Lake Michigan, saugers may reproduce only in Green Bay (Wells, pers. comm. 1980); the population is beginning to increase in the extreme southern part of Green Bay and in the Fox River (Kernen, pers. comm. 1979).

Wisconsin

WM-1

Little Tail Point (44°40', 87°59')--Little Sturgeon Bay (44°50', 87°33'). Saugers and walleyes were present together in this area during the spawning season. Before 1920, Peaks Lake and the area north to Little Tail Point was one of the most heavily used spawning areas in Green Bay (Coberly and Horrall 1980b).

Fox River (44°32', 88°00'). In 1975, a few eggs tentatively identified as those of sauger were entrained in April at the Pulliam Power Plant (44°32', 88°00') (NALCO, undated a).

Larsens Reef (44°53', 87°29'). This was considered a spawning area by commercial fishermen (Coberly and Horrall 1980b).

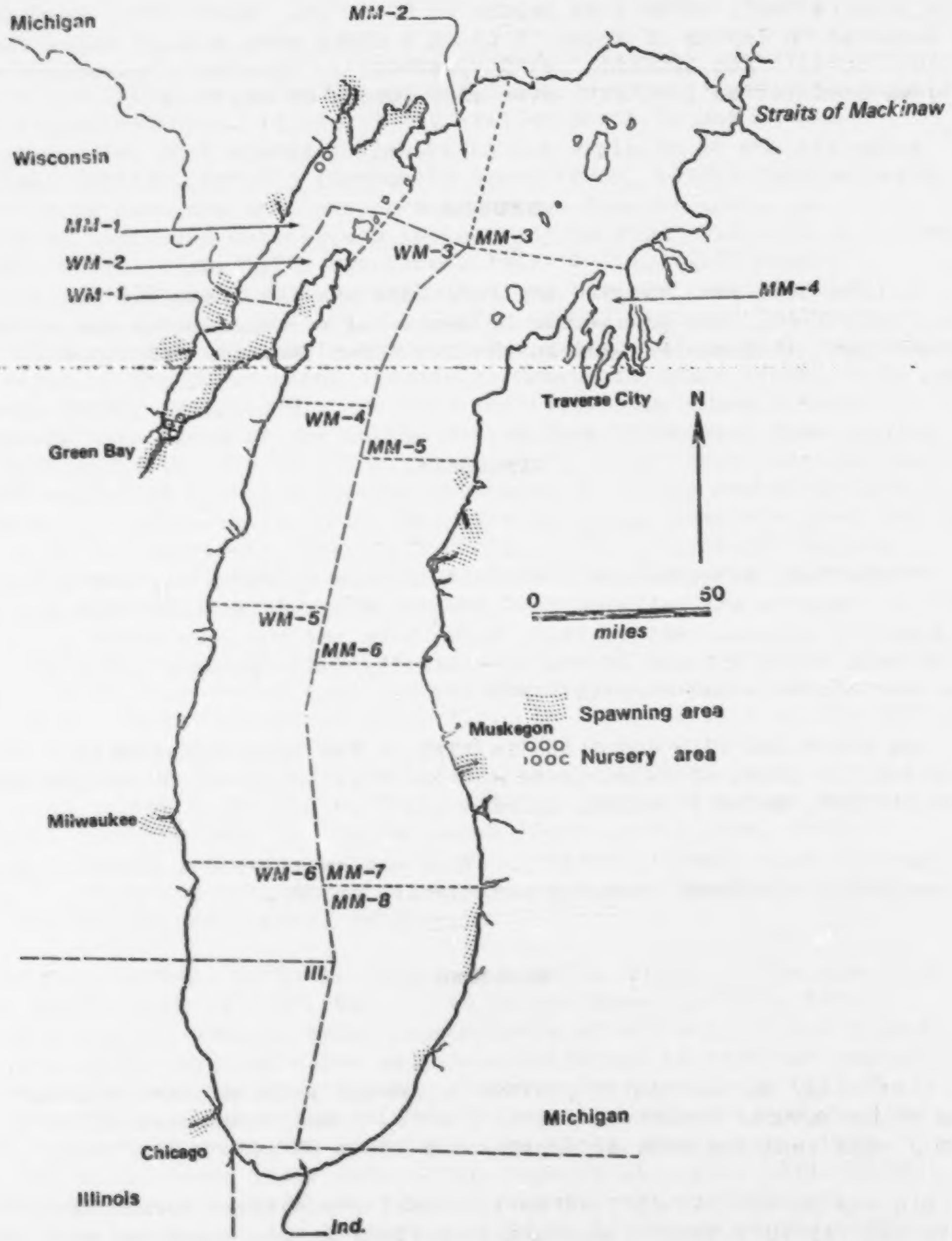
Michigan

MM-1

Little Bay de Noc (45°45', 87°00'). Until 1940, saugers spawned along shore between Gladstone (45°51', 87°00') and Stonington (45°46', 86°59') over sand and rock at depths of 6-18 ft (Organ et al. 1978).

Big Bay de Noc (45°45', 86°45'). Until the 1940s, saugers spawned in Ogontz Bay (45°50', 86°45') at depths of 12-24 ft over sand and rock and in an area between Stony Point (45°50', 86°39') and Valentine Point (45°51', 86°32') at depths of 6-12 ft over sand and gravel (Organ et al. 1978).

WALLEYE


Michigan
MM-2
Straits of Mackinaw
Wisconsin
MM-1
WM-2
WM-1
WM-3
MM-3
MM-4
Traverse City
N
Green Bay
WM-4
MM-5
0
50
miles
WM-5
MM-6
Spawning area
Muskegon
Nursery area
Milwaukee
WM-6
MM-7
MM-8
Ill.
Michigan
Chicago
Illinois
Ind.

Historically walleyes were abundant only in Green Bay and in the southeastern portion of the lake (Schneider and Leach 1977; USDI 1966); only a few walleyes existed elsewhere in the lake. Stocks were greatly reduced by the late 1800s due to destruction of spawning habitat and overfishing (Schneider and Leach 1977). In Green Bay, spawning in most tributaries has declined because of siltation, damming, industrial pollution, and eutrophication (Leach 1977; Schneider and Leach 1979). A major decline of the population in southern Green Bay began during the 1920s (Schneider and Leach 1979). Walleye fry are being planted in an attempt to replenish this population (WDNR 1977, 1979a). Tagging studies have shown that the walleye population in Green Bay is composed of a number of discrete spawning stocks; individuals in each of these stocks return to the same spawning site annually (Crowe 1962, 1964; Crowe et al. 1963; USBCF 1965; USDI 1966). Spawning occurs in tributaries and also on shoals in the bay (USBFC 1965; USDI 1966).

Wisconsin

WM-1

Menominee River (45°06', 87°35'). During the 1800s, a spawning run entered the river (Goode 1884). The river, which serves as the boundary between Wisconsin and Michigan, presently supports a small, self-sustaining spawning run (Copes and Ebener, pers. comm. 1979; Kernen and Belonger, pers. comm. 1979; Schneider and Leach 1977, 1979).

Peshtigo River (44°58', 87°39'). Historically, a major fishery was associated with the spawning run here (Schneider and Leach 1979). The river has been stocked and supports a small run (Kernen and Belonger, pers. comm. 1979; WDNR 1979a). The removal of dams on the river would increase access to prime spawning grounds (GLFC 1979b).

Oconto River (44°54', 87°50'). Historically, a major fishery was associated with the spawning run here (Schneider and Leach 1979). The river presently supports a small run (Kernen and Belonger, pers. comm. 1979). The removal of dams on the river would increase access to prime spawning grounds (GLFC 1979b).

Little Tail Point (44°40', 87°59')--Little Sturgeon Bay (44°50', 87°33'). This shoreline was considered by several commercial fishermen to be the best walleye spawning ground in the area; spawning occurred in water as shallow as 5-6 ft. Before 1920, the area from Little Tail Point to Peaks Lake (44°34', 88°02') was one of the most heavily used spawning areas in Green Bay (Coberly and Horrall 1980b). Historically, a spawning run occurred in the Fox River (44°32', 88°00'); a major fishery was associated with this run (Schneider and Leach 1979). A spawning run presently enters the river in May (Copes and Ebener, pers. comm. 1979; FWS 1979d; Kernen and Belonger, pers. comm. 1979). In 1975, a few eggs entrained at the Pulliam Power Plant (44°32', 88°00') on the lower river in April were tentatively identified as walleye eggs (NALCO, undated a). The area from the Fox River to Sable Point (44°35', 87°55') is a nursery ground; young-of-the-year were collected here but it is not known if these were naturally produced or stocked (Kernen, pers. comm. 1979). Young-of-the-year about 1.5-2.6 in. long were also collected in seines at Red River (44°40', 87°45') and Peaks Lake (Kernen 1979).

Larsens Reef (44°53', 87°29'). Walleyes spawn here (Coberly and Horrall 1980b; Copes and Ebener, pers. comm. 1979).

Sturgeon Bay (44°53', 87°24'). The shoals of Sturgeon Bay are spawning grounds (Kernen, pers. comm. 1979); peak spawning usually occurs here in late April (WDNR 1977).

WM-2

Fish Creek (45°08', 87°15'). Walleyes were stocked here, and spawning runs were documented in 1979 (Kernen, pers. comm. 1980).

WM-4

West Twin River (44°09', 87°34'). A few ripe fish were collected in the river, but spawning is not documented (Hanson, pers. comm. 1979).

WM-5

Milwaukee River (43°02', 87°54'). Historically, spawning runs entered the river in the spring (Gregory 1931, as cited in Poff and Threinen 1964).

Illinois

Calumet River (41°44', 87°32'). In 1875, a large run entered the river in the spring; but only an occasional walleye was found prior to or just after 1875 (Nelson 1878).

Michigan

MM-1

Cedar River (45°24', 87°21'). Walleyes spawned in the river over a gravel substrate during May and June (Organ et al. 1978).

Bark River (45°34', 87°14'). In 1978, walleye larvae were found at the 10 ft depth contour near the river mouth in late May (Wis. Elec. Power, unpubl. data).

Little Bay de Noc (45°45', 87°00') and Big Bay de Noc (45°45', 86°45'). Both bays are major spawning areas (Copes and Ebener, pers. comm. 1979). Historically, large numbers of walleyes spawned here in the spring (Goode 1884). Spawning runs occurred later here than in areas such as Saginaw Bay (44°00', 83°30') in Lake Huron, where the water warms earlier in the spring (Van Oosten 1938b). Tagging studies have shown that discrete populations of walleyes return each year to specific sites in the bays to spawn (Cook 1961; Crowe 1962, 1964; Crowe et al. 1963). Eggs were collected from ripe fish in Little Bay de Noc in 1931 and 1932 (Westerman 1933) and in 1961 and 1962 (Cook 1962; Schneider and Crowe 1977). Reefs in the Bay de Noc area (locations not identified) where fry have been stocked are also spawning sites; eggs have been collected at these sites (North Woods Call 1979f).

Gladstone (45°51', 87°00')--Stonington (45°45', 86°59'). Until 1940, walleyes spawned in this area over rock and sand in 6-18 ft of water (Organ et al. 1978). The Whitefish River (45°55', 86°57') supports a major spawning run (Crowe 1962; Norden, pers. comm. 1979; Schneider and Leach 1979; USDI 1966). In 1960-68, ripe adults were collected from the river in early May (Norden, pers. comm. 1979). In 1977, a good run of adults entered the river; it is not known if spawning was successful (FWS 1979d). Spawning may occur in the river about 4 mi above the river mouth and also in the bay near the river mouth (Crowe 1962; Schneider and Leach 1979). In 1930, eggs were collected from ripe fish at the mouth of the Days River (45°54', 86°59') in April and May (Westerman 1930, 1933).

Peninsula Point (45°40', 86°58')--Chippewa Point (45°43', 86°50'). From 1950-55, walleyes spawned along shore in April from just north of Peninsula Point to Chippewa Point, over rock in about 6 ft of water (Organ et al. 1978).

Ogontz Bay (45°50', 86°45'). Until the 1940s, spawning occurred in the bay over sand and rock at depths of 12-24 ft. Walleyes also spawned over rock at the mouth of the Ogontz River (45°52', 86°46') (Organ et al. 1978).

Nahma (45°50', 86°40'). Since the 1920s, walleyes have spawned in a sand area (45°49', 86°40') about 2 mi S of Nahma at a depth of about 12 ft (Organ et al. 1978). A spawning site is located at Nahma (Crowe 1962).

Stony Point (45°50', 86°39')--Valentine Point (45°51', 86°32'). Until the 1940s, walleyes spawned in this area over sand and gravel at depths of 6-12 ft. In 1950-55, spawning occurred over rock at the mouth of the Fishdam River (45°54', 86°35') (Organ et al. 1978).

Valentine Point (45°51', 86°32')--Kates Bay (45°49', 86°34'). Walleyes spawned here over rock at depths of 3-4 ft (Organ et al. 1978).

MM-6

Portage Lake (44°22', 86°14'). During the 1930s, walleyes spawned in a rock area (44°21', 86°18') about 1 mi off Portage Lake Channel at depths of about 3 ft (Organ et al. 1978).

Big Manistee River (44°15', 86°18'). In 1933, a spawning run entered the river in the spring (Mich. Conserv. 1933).

Big Sable River (44°02', 86°30'). From 1929-55, moderate numbers of walleyes congregated below the dam on the river; when netted and released, they continued upstream (Schneider and Leach 1979).

MM-7

Muskegon River (43°15', 86°15'). Records indicate that a majority of the population in southeastern Lake Michigan enters the Muskegon River to spawn (Consumers Power 1976f; Cook 1961, 1962; Crowe 1955, 1962; Eschmeyer 1949, 1950; Eschmeyer and Crowe 1955; Hazzard 1951; Mich. Conserv. 1933, 1935b; Tanner 1964; USDI 1966; Westerman 1952b, 1954, 1957a, 1959). Since 1923, this run has begun in late March or early April (Crowe 1955). No other stream on the eastern shore has had significant runs for at least several decades (Wells and McLain 1973; USDI 1966). The largest run in the Muskegon River probably occurred in 1933 (Schneider and Leach 1979). In 1944, 1947, and 1948, the maximum abundance of adults in the river occurred at water temperatures of 38°, 40°, and 44°F respectively (Eschmeyer 1949). In 1953 and 1954, which were typical years, more than 100,000 fish entered the river (GLFC 1957; Westerman 1954). The last major run probably occurred in 1960. Prior to 1969, spawning occurred just below the Newaygo Dam, approximately 40 mi upstream from Lake Michigan; spawning below the dam occurred in April, in 5-8 ft of water with a moderately fast current and a bottom of boulders, rubble, and gravel (Crowe 1955; Eschmeyer 1949, 1950; Eschmeyer and Crowe 1955; USDI 1966). Eggs were collected as far as 16 mi below the dam but were concentrated within the first 5 mi (Eschmeyer 1949). The Newago Dam was removed in 1969, providing about 12 mi of additional spawning habitat, but recruitment did not improve (Schneider and Leach 1979). Walleyes that spawn in this river exhibit a strong homing behavior; fish tagged in the river are caught nowhere else during subsequent spawning seasons (Crowe 1962; Schneider and Leach 1977, 1979; USBCF 1965; USDI 1966). By July, adult walleyes return to Lake Michigan and disperse widely along the eastern shore, moving as far south as Gary, Indiana (41°37', 87°20'), and as far north as Good Harbor Bay (44°58', 85°50') (Crowe 1962; GLFC 1957; Schneider and Crowe 1977; USBFC 1965; USDI 1966). It is assumed that fry drift down to Muskegon Lake (43°14', 86°18') after hatching in May and that the lake is an important nursery area (Schneider and Leach 1979).

MM-8

Saugatuck (42°40', 86°12'). Spawning occurred from the mouth of the Kalamazoo River south for 3 mi, to a depth of about 30 ft over rock and gravel (Organ et al. 1978).

Ganges (42°35', 86°13'). Spawning occurred in an area (42°34', 86°14'--42°36', 86°14') over gravel (Organ et al. 1978).

South Haven (42°24', 86°17'). Spawning occurred along shore in an area (42°25', 86°17'--48°28', 86°15') north of South Haven over sand, gravel, and rock (Organ et al. 1978).

St. Joseph (42°06', 86°29'). From the 1940s to 1959, spawning occurred immediately off St. Joseph over gravel in 7-20 ft of water, during late April to early June (Organ et al. 1978).

PERCID spp.

Indiana

Bailly Generating Station (41°39', 87°07'). In 1976 and 1978, a small number of percid larvae were collected near the plant at the 30 ft depth contour in June (Tex. Instrum. 1979a).

FRESHWATER DRUM

The freshwater drum is not common in Lake Michigan proper; the species is probably more abundant in Green Bay than elsewhere in the lake (Wells, pers. comm. 1979).

Wisconsin

WM-1

Little Tail Point (44°40', 87°59')--Peaks Lake (44°34', 88°02'). According to commercial fishermen, this area was one of the most heavily used spawning areas in Green Bay until about 1920 (Coberly and Horrall 1980b).

Fox River (44°32', 88°00'). In 1975, spawning occurred near the Pulliam Power Plant (44°32', 88°00') on the lower Fox River. Freshwater drum were 14% of the total larvae entrained at the plant. Most of the freshwater drum larvae entrained were prolarvae, about 0.2 in. long. Freshwater drum larvae were entrained from early June through mid-July; peak entrainment occurred in the first half of June (NALCO, undated a).

Indiana

Whiting (41°41', 87°30'). Historically, runs of freshwater drum began in early June at "South Chicago" (approximately at the present location of Whiting); in 1873, a large run occurred in July (Nelson 1878). This coincides with the known spawning period of freshwater drum.

MOTTLED SCULPIN

Illinois

Evanston (42°03', 87°40'). Young-of-the-year mottled sculpins were collected off Evanston in rock and rubble areas 20-50 ft deep from July to mid-September (Janssen, pers. comm. 1979). In 1980, gravid females were collected at 25-28 ft depths in mid-May; spawning had not yet taken place (Janssen, pers. comm. 1980).

Indiana

Bailly Generating Station (41°39', 87°07'). In 1976, larvae were entrained at the plant from the second week of June to mid-July (Tex. Instrum. 1976c, 1977b).

SLIMY SCULPIN

Slimy sculpins spawn at intermediate depths, in water shallower than that used by the deepwater sculpin (Brown, pers. comm. 1979; Wells, pers. comm. 1979). Spawning probably occurs in May in southeast Lake Michigan; slimy sculpin eggs have been found in yellow perch stomachs at this time (Wells 1980).

Wisconsin

WM-4

Kewaunee Power Plant (44°21', 87°32'). The collection of larvae less than 0.5 in. long in late May and many young-of-the-year (YOY) in July indicates that spawning occurs in the vicinity of the plant in May (LaJeone 1976, pers. comm. 1979).

Point Beach Power Plant (44°17', 87°32'). In 1972-77, spawning probably occurred in the vicinity of the plant (Wis. Elec. Power and Wis.-Mich. Power, undated c). In 1976, ripe males and females were impinged at the plant in mid- to late February and from late April to mid-May (Wis. Elec. Power 1976c). Slimy sculpin larvae and YOY are collected in this area from late March to September (Wis. Elec. Power and Wis.-Mich. Power, undated c).

WM-5

Haven (43°51', 87°44'). In 1974, larvae were collected here (Wis. Elec. Power et al. 1979b). Fry and YOY were collected in inshore areas over a hard clay and cobble bottom in July. Spawning probably occurs in May (LaJeone, pers. comm. 1979).

Sheboygan (43°45', 87°42'). In 1975-76, slimy sculpin eggs and larvae were entrained at the Edgewater Power Plant (43°43', 87°42') in May and from late June to August respectively. Nearly ripe and ripe adults were impinged in April and May, and spawning is believed to occur in the area prior to June (CDM/Limnetics 1977; Swanson Environ. 1976).

Port Washington (43°23', 87°52'). In 1975-76, eggs, which were probably slimy sculpin eggs, and larvae were entrained at the Port Washington Power Plant (43°23', 87°52') (CDM/Limnetics 1977; Wis. Elec. Power 1976e). A few ripe adults were impinged at the plant during mid-March to late July; peak impingement occurred from late April to early May (Wis. Elec. Power 1976e).

Milwaukee (43°02', 87°54'). In 1975, eggs and YOY, believed to be slimy sculpins, were collected off Whitefish Bay at 43°08', 87°47' in about 165 ft of water; the eggs were collected from a log on a rocky substrate in May, and the YOY were collected among rocks in August (Janssen, pers. comm. 1979). Ripe adults and eggs were collected from the bottom in 50 ft of water off Milwaukee in May and June (Binkowski, pers. comm. 1979; Norden, pers. comm. 1979).

Oak Creek Harbor (42°51', 87°50'). In 1975, a few ripe adults were collected near the Oak Creek Power Plant (42°51', 87°50') from late April to mid-May (Wis. Elec. Power 1976d). Eggs, which were probably slimy sculpin eggs, were entrained at the plant in April and May (CDM/Limnetics 1977).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). Spawning occurs in this area (Commonw. Edison 1976; Ind. Bio-Test 1975; Muench, pers. comm. 1979). Ripe adults were collected in May; all fish collected in June were spent. Although adults migrated inshore to the 20-30 ft depth contours in April and May, the absence of eggs and larvae at these depths suggests that these adults may have returned to deeper water to spawn (Cochran, undated). The Zion-Waukegan area is a nursery ground; larvae and YOY are present from June to October at the 40-60 ft depth contours (Cima 1977; Cima and Cochran, undated; Cima et al. 1976; Cochran and Cima 1974; Ind. Bio-Test 1975b).

Indiana

Hammond (41°40', 87°30'). Slimy sculpins are believed to spawn successfully in the vicinity of the Stateline Generating Station (41°42', 87°31'); a few larvae were collected here in 1975-76 (NALCO 1976c).

Gary (41°37', 87°20'). A few slimy sculpin eggs and larvae were collected at the Mitchell Power Station (41°37', 87°22') in July (CDM/Limnetics 1977; Krueger 1976).

Bailly Generating Station (41°39', 87°07'). In 1976, eggs were entrained at the station during the second through the fourth weeks of May; larvae were entrained in the second and third weeks of June and the first week of July (Tex. Instrum. 1976c, 1977b).

Michigan

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). Larvae and YOY were collected on rocky areas of the jetties at the plant; this area is a spawning and nursery ground (Brazo, pers. comm. 1979).

MM-7

Port Sheldon (42°54', 86°13'). In 1964, ripe females were collected in an area between Port Sheldon and Saugatuck (42°40', 86°12') at about the 102-270 ft depth contours over substrate ranging from fine sand to mud. Peak abundance occurred at a depth of 102 ft early in the spring and at a depth of 150 ft later in the spring. Most fish were collected on the bottom at water temperatures lower than about 43°F. Spawning probably began sometime before May 5 (Rottiers 1965). Gonads of fish collected near Port Sheldon in 1978 indicated that spawning occurred in the vicinity in late May (Jude et al. 1979a). In 1977, a few slimy sculpin larvae were collected south of the Campbell Power Plant discharge (42°55', 86°12') on July 7 (Jude et al. 1978).

MM-8

Saugatuck (42°40', 86°12'). Adults move shoreward to depths as shallow as 42 ft in mid-April; this movement may be related to spawning. Larvae are found in the area in midwater, mainly in the hypolimnion (Wells 1968).

Palisades Power Plant (42°19', 86°19'). Most slimy sculpins were impinged at the plant in the spring during the spawning period, and it appears that spawning is occurring at relatively shallow depths (Consumers Power 1975). In 1972, over 7,000 adult slimy sculpins were impinged from mid-May through June; about 350 of these were ripe (Consumers Power 1972b). In 1974-75, 5,000 fertile eggs and a few yolk-sac larvae were collected from intake water at the plant (Consumers Power 1976g).

Bridgman (41°56', 86°35'). Ripe-running adults are collected in this area in April and May (Jude, pers. comm. 1979; Jude et al. 1975). Spawning occurs on the intake and discharge structures of the Cook Power Plant (41°59', 86°34'); in 1974, divers observed clumps of eggs on the riprap of the structures on May 21-22 at a water temperature of 52°F (Indiana and Mich. Power 1975; Jude et al. 1975). Larvae are found in late June; YOY appear in trawl catches in July (Jude, pers. comm. 1979; Jude et al. 1975, 1979b).

FOURHORN SCULPIN

In Lake Michigan, fourhorn sculpins probably spawn in the winter in water deeper than 240 ft (Wells, pers. comm. 1979, 1980; Wells and McLain 1973). From the late 1960s to the mid-1970s, stomachs of fourhorn sculpins collected in November contained many of their own eggs (Wells 1980). Fourhorn sculpin larvae are usually found in the hypolimnion in deeper areas of the lake (Wells 1968; Wells, pers. comm. 1979); some larvae are also present in shallower nearshore areas, when low water temperatures prevail in those areas (Wells, pers. comm. 1979). In the southern portion of the lake, fourhorn sculpins spawn at depths greater than 240-270 ft, and the young are also found in deep water (Brown, pers. comm. 1979).

Wisconsin

WM-5

Haven (43°51', 87°44'). In 1977-79, larvae were collected here at the 30 and 40 ft depth contours in April (Wis. Elec. Power, unpubl. data; Wis. Elec. Power et al. 1979).

Port Washington (43°23', 87°52'). Larvae were collected off the Port Washington Power Plant (43°23', 87°52') from April to mid-May; peak abundance occurred in late April at the 40 ft depth contour. Larvae were entrained at the plant (CDM/Limnetics 1977; Wis. Elec. Power, unpubl. data).

Illinois

Zion (42°27', 87°48')--Waukegan (42°22', 87°50'). In 1975, a few larvae were collected from the lake in this area in April (Cima et al. 1976). In 1977, larvae were collected in March, April, May, and August (Cima 1977). Spring upwellings and alongshore currents may have moved the larvae into these areas from the deeper offshore waters (LaJeone, pers. comm. 1979).

Indiana

Bailly Generating Station (41°39', 87°07'). Spawning may occur in this area; however in 1975 only one larva was collected in 50 ft of water near the plant in June (Tex. Instrum. 1976a).

Michigan

MM-6

Ludington Pumped Storage Plant (43°54', 86°27'). In 1978, larvae were collected near the plant (Liston et al. 1978). Larvae are found in the area from mid-April to mid-May, mainly in offshore waters (Brazo, pers. comm. 1979).

MM-7

Port Sheldon (42°54', 86°13'). Larvae were found occasionally in this vicinity in April and May at depths greater than about 20 ft (Jude 1978). The first appearance of larvae in early February suggests that spawning occurs in December (Jude et al. 1979a). Larvae were entrained at the Campbell Power Plant (42°55', 86°12') from February to May; highest densities occurred in mid-April (Jude 1978; Jude et al. 1979a). The offshore areas are believed to be nursery grounds; no larvae are collected in the nearshore waters after May (Heufelder, pers. comm. 1979; Jude et al. 1979a). In 1977, two larvae were collected in August in deep water south of the plant discharge (Jude et al. 1978).

MM-8

Bridgman (41°56', 86°35'). Larvae were collected in water abut 70 ft deep in April and May; this is probably a nursery area. Spawning usually takes place offshore in the winter (Jude, pers. comm. 1979).

SCULPIN spp.

Wisconsin

WM-3

Rowley Bay (45°13', 87°01'), North Bay (45°09', 87°04'), Moonlight Bay (45°05', 87°05'), and Baileys Harbor (45°03', 87°07'). Ripe sculpins were collected in gill nets set near these bays (Frederick, pers. comm. 1979).

WM-4

Point Beach Power Plant (44°17', 87°32'). Sculpin eggs and larvae were more abundant than those of most other species found in this area. Young-of-the-year (YOY) were also collected in shore seines (Wis. Elec. Power, undated a).

Manitowoc (44°05', 87°39'). In 1975, four sculpin eggs were collected at the Manitowoc Generating Plant (44°05', 87°39') on May 22-23, and small numbers of larvae were collected at the surface from early July to mid-August (CDM/Limnetics 1976a).

WM-5

Haven (43°51', 87°44'). Sculpin larvae were collected here in June to September; peak abundance occurred in July at the 30 and 40 ft depth contours (Wis. Elec. Power, unpubl. data).

Sheboygan (43°45', 87°42'). Sculpins are believed to spawn successfully in the vicinity of the Edgewater Generating Station (43°43', 87°42'); divers observed many YOY, and a few postlarvae were entrained in late February and late March (Swanson Environ. 1979).

Port Washington (43°23', 87°52'). A few eggs and larvae were entrained at the Port Washington Power Plant (43°23', 87°52') from April through August. A few eggs and larvae were also collected in the lake in the vicinity of the plant from July to September; peak abundance occurred in July (Wis. Elec. Power, unpubl. data, 1976e).

Oak Creek Harbor (42°51', 87°50'). In 1972-73, fry less than 0.5 in. long were collected at the Oak Creek Power Plant (42°51', 87°50') in March and April (Limnetics 1974; Wis. Elec. Power 1975b, 1976d).

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16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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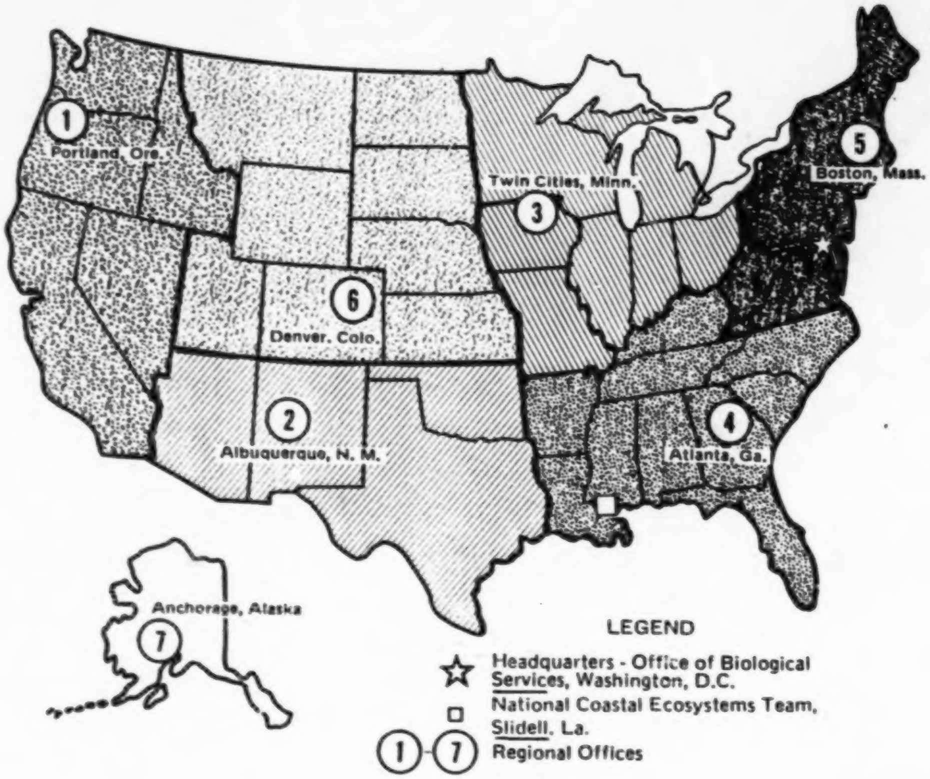
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82/52/v.5

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FWS/OBS-82/52
SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume V-Lake Huron

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME V
Lake Huron

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area
II. Lake Superior
III. St. Marys River
IV. Lake Michigan
V. Lake Huron
VI. St. Clair River
VII. Lake St. Clair
VIII. Detroit River
IX. Lake Erie
X. Niagara River
XI. Lake Ontario
XII. St. Lawrence River
XIII. Reproductive Characteristics of Great Lakes Fishes
XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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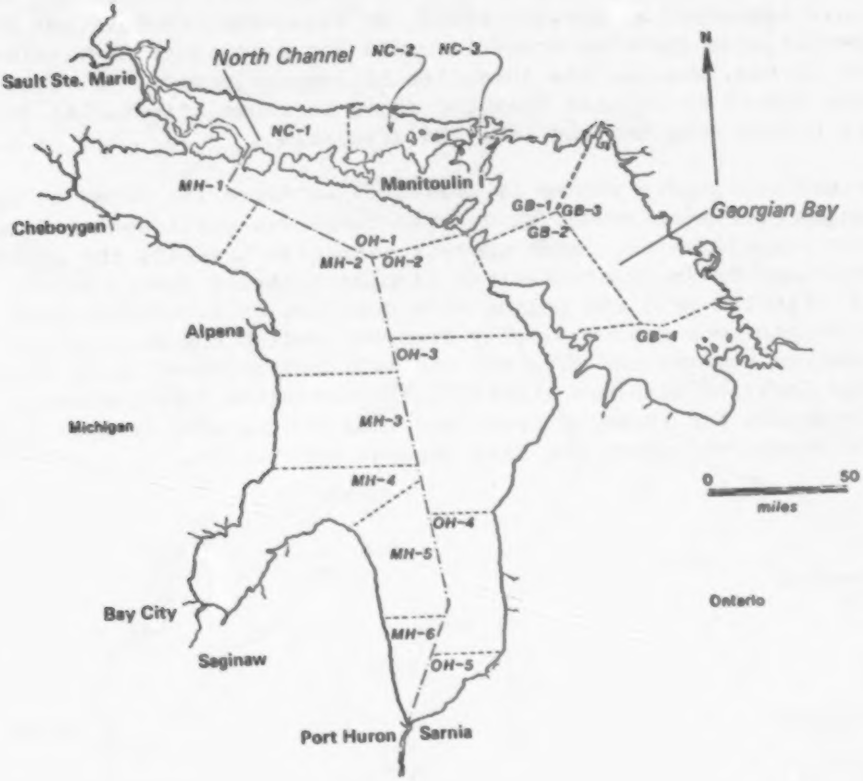
North Channel
NC-2
NC-3
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Sault Ste. Marie
NC-1
Manitoulin I
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Cheboygan
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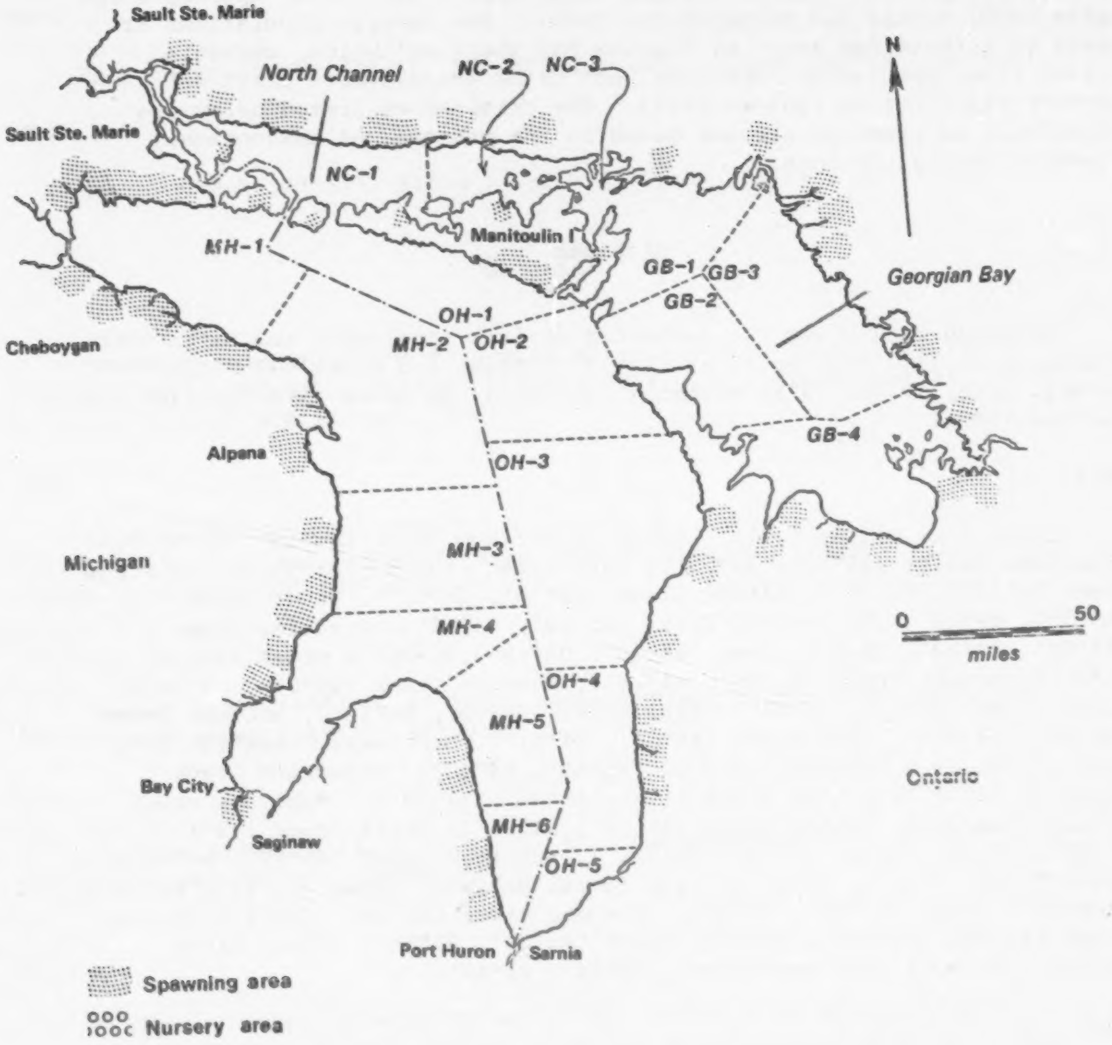
Almost 90 species of fish have been recorded as residents in Lake Huron (Argyle, pers. comm. 1979; Emery 1976; MWRC 1975). This volume describes the reproductive habitat used by the 61 species for which information was available. Forty-seven species treated in this volume were native to the lake. Most of these 47 native species spawned (or spawn) in tributaries or in shallow, protected waters of the lake. Only the lake trout, five species of ciscoes, and the fourhorn sculpin, utilized the deep offshore waters for spawning. Four of these deepwater spawners, the blackfin cisco, shortjaw cisco, deepwater cisco, and kiyi are now believed to be extinct in Lake Huron. Only the lake trout spawned in the shallow nearshore waters and also the deeper offshore waters.

The 14 exotic species treated in this volume were introduced by man or immigrated to the lake during the period of record, from populations established elsewhere in the Great Lakes drainage. Eight of these are salmonids which spawn in tributaries; the other six exotic species spawn in tributaries and also in protected nearshore waters in some areas. The splake, an artificial hybird created by crossing two native species (brook trout and lake trout), apparently spawns in the nearshore waters.

Information on nursery areas used by the 61 species treated in this volume is fragmentary, but as would be expected, it suggests that tributaries and nearshore waters are important as nursery areas, at least for the earliest life stages. Dispersal from spawning areas is rapid for some species which have small, pelagic larvae, whereas the juveniles of some salmonids that spawn in tributaries may remain in or near spawning areas in those tributaries for as many as three years before entering the lake and dispersing.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Each species narrative presents the available information systematically by statistical fishing district (Smith et al. 1961) beginning with district MH-1 and ending with district GB-4. Within each district the presentation proceeds systematically from one end of the district to the other, by shoreline segment and adjacent littoral and offshore water areas. For each referenced location within a district, the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

SEA LAMPREY


Sault Ste. Marie
North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
Manitoulin I
MH-1
GB-1
GB-3
Georgian Bay
GB-2
OH-1
MH-2
OH-2
Cheboygan
GB-4
Alpena
OH-3
MH-3
Michigan
0
50
miles
MH-4
OH-4
MH-5
Ontario
Bay City
MH-6
Saginaw
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

The sea lamprey probably entered Lake Huron from Lake Erie via the St. Clair-Detroit River System. A spawning run observed in the Ocqueoc River in 1937 was the first reported occurrence of sea lamprey in the lake; by the early 1940s, major spawning runs had developed in a number of rivers (Shetter 1949).

Many of the tributaries to Lake Huron provide ideal spawning habitat for the sea lamprey (Dees 1980). Ammocoetes have been found in at least 105 tributaries to the lake and also in bays and in the lake off tributary mouths (Braem and Rugen 1976; Dees 1980; GLFC 1975; Wagner and Stauffer 1962; Wagner et al. 1972). Spawning runs occur in April-July and usually peak in May to mid-June (Applegate 1950, 1951a; Applegate and Smith 1950; MacKay and MacGillivray 1949). Sea lamprey populations are small in tributaries south of Saginaw Bay where pollution, unstable stream flow, unsuitable substrate, and water temperatures limit or prevent reproduction (Morman 1979). The tributaries listed below are classified as spawning streams based on the presence of ammocoetes, spawning adults, or both.

Michigan

Spawning runs enter the following streams (Applegate and Smith 1950; Applegate et al. 1952; Bails et al. 1971; Braem and Rugen 1976; GLFC unpubl. data, 1973b, 1975; Morman 1979; Smith and Braem 1976; Torblaa and Westman 1980).

MH-1

Canoe Lake Outlet (45°57, 83°42'), Caribou Creek (45°58', 83°59'), Bear Lake Outlet (45°58', 83°59'), Carr Creek (45°58', 83°59'), Joe Straw Creek (45°57', 84°00'), Albany Creek (45°58', 84°05'), Trout Creek (45°59', 84°06'), Beavertail Creek (45°59', 84°12'), Prentiss Creek (45°59', 84°14'), McKay Creek (46°00', 84°18'), Ceville Creek (46°00', 84°21'), Hessel Creek (46°00', 84°25'), Steeles Creek (46°01', 84°28'), Nunns Creek (46°02', 84°34'), Pine River (46°03', 84°39'), McCloud Creek (46°03', 84°40'), Carp River (46°02', 84°41'), Martineau Creek (45°58', 84°43'), unnamed tributary 266-20 (45°46', 84°42'), Beaugrand Creek (45°41', 84°33'), Little Black River (45°40', 84°29'), Cheboygan River (45°39', 84°28'), Elliot Creek (45°39', 84°25'), Grass Creek (45°39', 84°22'), Greene Creek (45°38', 84°14'), Mulligan Creek (45°37', 84°12'), Grace Creek (45°34', 84°08'), Carp (Black Mallard) Creek (45°32', 84°07'), Seventeen Creek (45°30', 84°06'), Ocqueoc River (45°29', 84°04'), Johnny Creek (45°29', 84°00'), Schmidt Creek (45°29', 83°56'), Trout River (45°26', 83°50'), and Swan River (45°24', 83°44').

MH-2

Middle Lake Outlet (45°10', 83°22'), Squaw Creek (45°00', 83°28'), and Devils River (44°55', 83°25').

MH-3

Black River (44°49', 83°18') and Au Sable River (44°24', 83°19').

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MH-4

Tawas River (44°16', 83°31'), East Branch Au Gres River (44°09', 83°34'), Au Gres River (44°02', 83°41'), Rifle River (44°00', 83°45'), and Saginaw River (43°39', 83°51').

MH-5

Rock Falls Creek (43°49', 82°38') and Sucker Creek (43°45', 82°37').

MH-6

Cherry Creek (43°31', 82°34') and Mill Creek (43°13', 82°31').

Ontario

Spawning runs enter the following streams (GLFC 1973b, 1975; SLCC 1979a,b; Smith and Tibbles 1980; Tibbles 1959, 1975; Tibbles et al. 1976a,b; Torblaa and Westman 1980).

OH-1

Sand Creek (45°52', 83°21'), Mindemoya River (45°40', 82°16'), Manitou River (45°36', 82°06'), Blue Jay Creek (45°35', 82°05'), and Kaboni Creek (45°42', 81°46').

OH-3

Sauble River (44°40', 81°17'), Saugeen River (44°30', 81°23'), and Penetangore River (44°11', 81°39').

OH-4

Lucknow River (43°53', 81°43'), Maitland River (43°45', 81°44'), and Bayfield River (43°34', 81°43').

NC-1

Kaskawong River (Milford Haven Creek) (46°09', 83°50'), unnamed tributary H-65 (St. Joseph Island, location uncertain), unnamed tributary H-68 (St. Joseph Island, location uncertain), MacBeth Creek (46°17', 83°37'), Thessalon River (46°15', 83°34'), Livingstone Creek (46°15', 83°29'), Mississagi River (46°10', 83°01'), Blind River (46°11', 82°57'), Lauzon Creek (46°11', 82°49'), Spragge River (46°12', 82°40'), Serpent River (46°13', 82°37'), and Silver Creek (45°55', 82°50').

NC-2

Spanish River (46°11', 82°19') and Kagawong River (45°54', 82°15').

GB-1

Chickanishing River (45°59', 81°25').

GB-3

French River (45°56', 80°54'), Key River (45°53', 80°44'), Still River (45°46', 80°34'), Magnetawan River (45°46', 80°38'), Naiscoot River (45°40', 80°34'), Boyne River (45°18', 80°02'), and Squirrel Creek (45°17', 80°04').

GB-4

Sydenham River (44°35', 80°56'), Telfer (Bothwell's) Creek (44°38', 80°52'), Beaver River (44°34', 80°27'), Silver Creek (44°31', 80°17'), Pretty River (44°30', 80°12'), Nottawasaga River (44°33', 80°00'), LaFontaine Creek (44°44', 80°04'), Hog Creek (44°45', 79°47'), Sturgeon River (44°44', 79°44'), and Muskoka River (44°57, 79°53').

LAKE STURGEON

Lake sturgeon spawned over a sandy substrate at the southern end of the lake during June and July; however, sturgeon were found to have "well-developed" eggs throughout the year (Rathbun and Wakeham 1897).

Michigan

MH-3

Au Sable River (44°24', 83°19'). Before dams were built on the river in 1911, sturgeon migrated about 88 mi upstream in the spring to the mouth of the North Branch (Miller 1966, as cited in Schneider and Leach 1979). In the spring of 1935, a sturgeon attempted to spawn at Foote Dam (Mich. Cons. 1935a), about 17 mi upstream from the mouth.

MH-4

Saginaw Bay (44°00', 83°30'). In the early 1900s, spawning occurred over a mud and sand bottom along the east shore of Saginaw Bay between Fish Point (43°43', 83°31') and Sand Point (43°55', 83°24') (Organ et al. 1978).

Ontario

GB-3

Lake sturgeon ascended rivers along the east shore of Georgian Bay in June (Bensley 1915).

GB-4

Musquash River (44°58', 79°53'). Lake sturgeon ascended the river in early June (Ont. Game Fish 1912).

Nottawasaga River (44°33', 80°00'). Lake sturgeon ascended the Nottawasaga River in May (Bensley 1915).

LONGNOSE GAR

Ontario

GB-4

Go Home Bay (44°59', 79°57'). Longnose gar built nests in Go Home Bay on the east shore of Georgian Bay (45°30', 81°00') during mid-June; the nests were constructed in 2 ft of water among the short stems of aquatic plants (Bensley 1915).

GAR spp.

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). An unidentified species of gar spawned in Saginaw Bay from just east of Wigwam Bay (43°59', 83°50') to Saganing Bar (43°55', 83°51') over mud, sand, and vegetation (Organ et al. 1978). Gravid females were collected at the Karn-Weadock Power Plant Complex (43°39', 83°51') from late April through the end of June (Beak Consult. 1976).

BOWFIN

Michigan

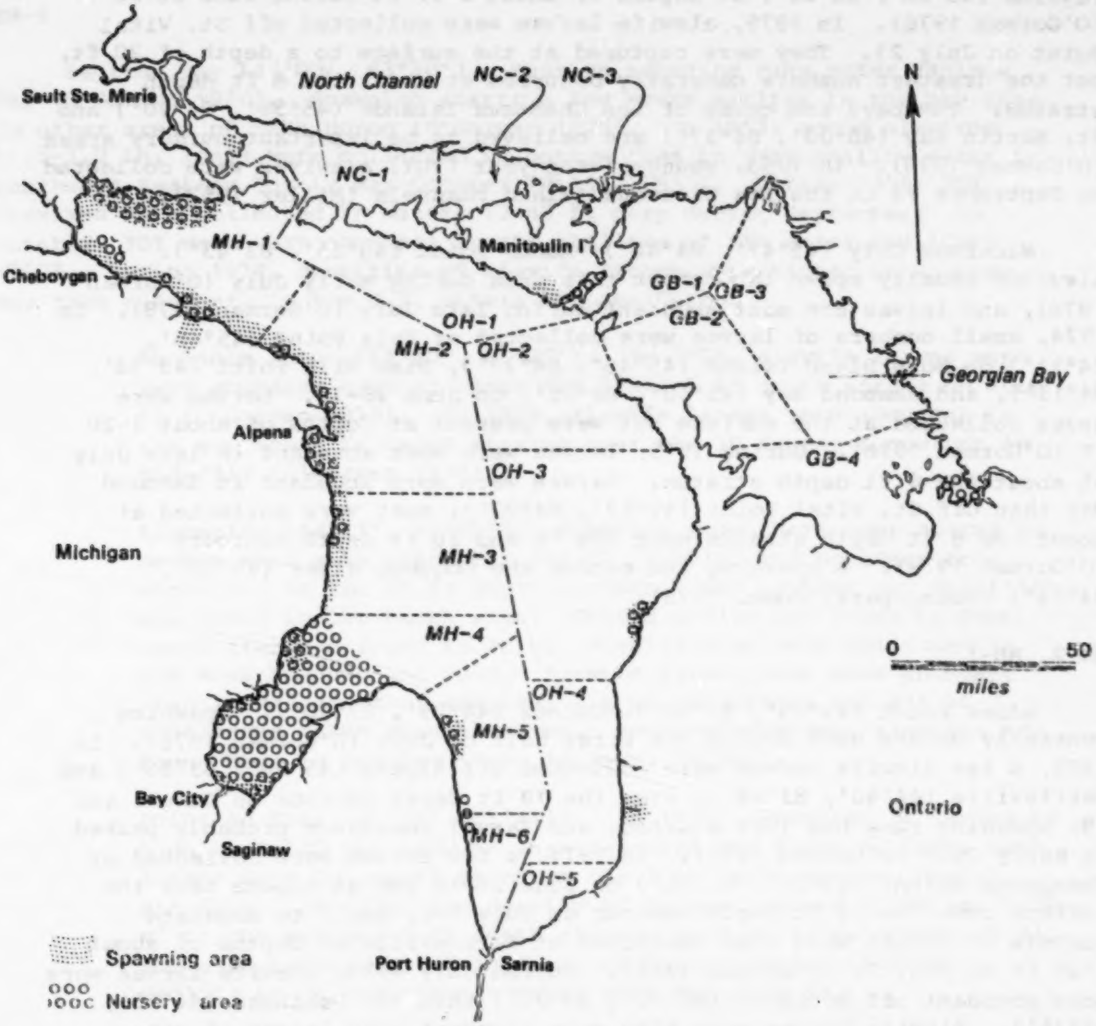
MH-4

Saginaw Bay (44°00', 83°30'). Spawning occurred between Point Au Gres (43°59', 83°41') and Saganing Bar (43°55', 83°51') in late May over mud in 1-2 ft of water, and over sand and muck between Fish Point (43°43', 83°31') and Sebewaing (43°44', 83°27') (Organ et al. 1978).

Ontario

In Georgian Bay (45°30', 81°00') spawning occurs in late May; eggs are deposited in large, open depressions made in mud among plant roots (Bensley 1915).

ALEWIFE


Sault Ste. Marie
North Channel
NC-2
NC-3
N
NC-1
MH-1
Cheboygan
Manitoulin I.
GB-1
GB-3
GB-2
OH-1
MH-2
OH-2
Georgian Bay
Alpena
OH-3
GB-4
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Bay City
Ontario
Saginaw
MH-6
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

The alewife presumably entered Lake Huron from Lake Erie via the St. Clair-Detroit River System. The first recorded collection of alewives in Lake Huron occurred in 1933 (Miller 1957).

Michigan

MH-1

Point De Tour (45°57', 83°55')--St. Ignace (45°52', 84°43'). Spawning occurs in U.S. waters along the north shore of the lake during early July, and fry are most abundant in late July. In 1974, however, larvae were collected off St. Vital Point (45°57', 84°00') and Point Fuyards (45°56', 84°23') at depths of about 3-20 ft during June 26-30 (O'Gorman 1976). In 1975, alewife larvae were collected off St. Vital Point on July 23. They were captured at the surface to a depth of 20 ft, but the greatest numbers generally occurred at about the 6 ft depth stratum. The bays and coves of Les Cheneaux Islands (45°58', 84°20') and St. Martin Bay (46°00', 84°37') are believed to be important nursery areas (O'Gorman 1978). In 1955, young-of-the-year (YOY) alewives were collected on September 14 in the Les Cheneaux Island channels (Miller 1957).

Mackinaw City (45°47', 84°44')--Adams Point (45°25', 83°43'). Alewives usually spawn throughout this area during early July (O'Gorman 1976), and larvae are most abundant during late July (O'Gorman 1978). In 1974, small numbers of larvae were collected at Zela Point (45°46', 84°31') on Bois Blanc Island (45°46', 84°27'), Nine Mile Point (45°38', 84°13'), and Hammond Bay (45°30', 84°05') on June 26-30. Larvae were never collected at the surface but were present at depths of about 3-20 ft (O'Gorman 1976). During 1975, larvae were most abundant in late July at about the 6 ft depth stratum. Larvae were more abundant in Hammond Bay than off St. Vital Point (45°57', 84°00'); most were collected at about the 6 ft depth stratum over the 18 and 30 ft depth contours (O'Gorman 1978). A spawning run enters the Ocqueoc River (45°29', 84°04') (Hunn, pers. comm. 1979).

MH-2, MH-3

Adams Point (45°25', 83°43')--Oscoda (44°25', 83°20'). Spawning generally occurs here during the first half of July (O'Gorman 1976). In 1973, a few alewife larvae were collected off Alpena (45°04', 83°26') and Harrisville (44°40', 83°18'), over the 18 ft depth contour on June 5 and 19; spawning runs had just started, and larval abundance probably peaked in early July (O'Gorman 1975). In 1974, a few larvae were collected at Thompsons Harbor (45°21', 83°36') on June 26-30 and at Alpena near the surface over the 30 ft depth contour on July 1-2; small to moderate numbers of larvae were also collected at Harrisville at depths of about 3-20 ft on July 10 (O'Gorman 1976). During July 1975, alewife larvae were more abundant off Rockport (45°12', 83°23') than off Ossineke (44°55', 83°25'). Alewife larvae were also more abundant than larvae of other species in the littoral zone at Rockport and Ossineke. Alewife larvae were concentrated at about the 10 ft stratum at Rockport and at about the 3 ft stratum near Ossineke, over the 18 ft depth contour; at the 30 ft depth contour, larvae were concentrated near the surface at both Rockport and Ossineke. Alewife larvae were present at Rockport, Alpena, and Ossineke during mid-August. The southern and western shores of Thunder Bay (45°00', 83°20') are important spawning and nursery areas for alewives. The northern shore of the bay is subject to upwellings, and larvae are not abundant there (O'Gorman 1978).

In 1978-79 at Rockport, alewife prolarvae and postlarvae were more abundant than those of most other species. Prolarvae were most abundant in July at mid-depths over the 18 ft depth contour. Most of these larvae may have drifted into the area from spawning grounds located elsewhere (Tex. Instrum. 1979c).

MH-4

Saginaw Bay (44°00', 83°30'). Massive spawning runs enter Saginaw Bay (O'Gorman 1978). Spawning starts a few weeks earlier in the bay than in other areas of Lake Huron (O'Gorman 1975). In 1953, young alewives (1.5-3.0 in. long) were collected in bottom tows in very shallow water in southwest Saginaw Bay in May-October (Miller 1957). During 1956, YOY alewives were collected in waters 12-45 ft deep during September. In October, YOY were very abundant in the shallows of the outer bay (Carr 1962). During 1974, densities of alewife larvae were higher in Saginaw Bay than elsewhere in the U.S. waters of Lake Huron.

Au Sable Point (44°20', 83°20'). In 1974, alewife larvae were very abundant here at about the 3 and 6 ft depth strata on July 13 (O'Gorman 1976). In 1975, alewife larvae were abundant in the surface-6 ft depth stratum over the 30 ft depth contour in mid-July (O'Gorman 1978).

Alabaster (44°11', 83°33'). Alewives spawn here over coarse to medium sand with scattered gravel, rubble, and boulders from shore out to the 25 ft depth contour. The highest egg densities are found in the beach zone. Gravid adults are found in June; spent fish are found in July. Alewife eggs were collected in the area in June and July. Alewife larvae were more abundant than larvae of other species; 71% of prolarvae, and 31% of postlarvae taken were alewives. Young-of-the-year alewives are found here in October (Tex. Instrum. 1979b,d).

Point Au Gres (43°59', 83°41'). In 1973, densities of larvae as high as 2,700 per 1000 m^3 were measured off Point Au Gres; most larvae were collected at about the 3 ft depth stratum during mid-June. In 1974, the density of larvae reached 7,740 per 1000 m^3 in the surface-3 ft depth stratum on July 12 (O'Gorman 1978). The area between Point Au Gres and Point Lookout (44°03', 83°35') is an important nursery area for alewife.

Wigwam Bay (43°59', 83°50'). Spawning occurs here over clay and sand in water as deep as 6 ft (Organ et al. 1978).

Saginaw River (43°39', 83°51'). At the Karn-Weadock Power Plant Complex (43°39', 83°51'), at the river mouth, the heaviest impingement of adults occurred during June to mid-July (Consumers Power 1976c,d). Adult alewives began moving into inner Saginaw Bay in April and reached peak density in May-July; spawning occurred in late June and July, and most adults had left the nearshore zone by late July. Larvae first appeared in large numbers in late July (Beak Consult. 1976). In 1973, off

Bay City (43°36', 83°52'), densities of larvae as high as 1,259 per 1000 m^3 were measured at about the 10 ft depth stratum on June 17 (O'Gorman 1978).

Quanicasse (43°35', 83°40'). Gravid females were present in late June at the Quanicasse Power Plant site (43°35', 83°40'). Spawning occurred throughout the area, but appeared to be concentrated in the shallow beach zone, over a sand bottom. Alewife eggs were collected in June, and alewife larvae were more numerous than those of other species in June and July (Tex. Instrum. 1979b,e).

Port Austin (44°03', 83°00'). In 1974, large numbers of alewife larvae were collected here in the 3-6 ft depth stratum over the 18 and 30 ft depth contours in mid-July. In 1975, larvae were abundant during mid-July, mainly at about the 3 ft depth stratum over the 18 and 30 ft depth contours. By mid-August, very few alewife larvae were collected (O'Gorman 1978).

MH-5

Harbor Beach (43°51', 82°39')--Richmondville (43°34', 82°36'). In 1974, alewife larvae were abundant off Harbor Beach and Richmondville on July 14. Off Harbor Beach they were concentrated at about the 3 ft depth stratum along the 18 ft depth contour, and off Richmondville at about the 3 ft depth stratum along the 30 ft depth contour (O'Gorman 1976). During mid-July 1975, larvae were more abundant off Harbor Beach than off Richmondville; small numbers were collected during August at both sites (O'Gorman 1978). At Harbor Beach, ripe and running adults, eggs, and larvae were collected from the harbor and north from the harbor for 5 mi at depths out to 45 ft. The substrate in this area is large rocks and boulders (LaJeone, pers. comm. 1979).

Ontario

OH-1

Manitoulin Island (45°50', 82°30'). During 1967-1969 and 1973-1975, alewives were collected at the Canadian Department of Fisheries and Oceans (CDFO) sea lamprey weir in the Manitou River (45°36', 82°06') (FWS 1979c). Young-of-the-year alewives were found in the shallowest and warmest waters of South Bay (45°38', 81°52') during June-August 1964-69 (Faber 1964; Reckahn 1970).

OH-3

Douglas Point (44°19', 81°36'). Alewife eggs are found in the area of the Bruce Generating Plant during late June-early August (Dunstall 1978a). The alewife larvae are more abundant than those of other species at Douglas Point and in Baie du Dore (44°21', 81°34') (Dunford 1978b; Dunstall 1978a). Young-of-the-year are found here in late summer (Kelso and Leslie 1979).

OH-4

Bayfield River (43°34', 81°43'). In 1966, a few alewives were collected in the CDFO sea lamprey weir in the Bayfield River (FWS 1966).

NC-1

St. Joseph Island (46°13', 84°00'). During 1973, alewives were collected in the CDFO sea lamprey weir in the Kaskawong River (Milford Haven Creek) (46°09', 83°50) (FWS 1979c).

GB-4

Matchedash Sound (44°50', 79°50'). In 1979, larvae were collected here during June and early July. Most larvae were found in the inner portion of the sound at Bergie Point (44°45', 79°47') on July 4 (Loftus 1977).

GIZZARD SHAD

Gizzard shad were present in Lake Huron in the 1870s and presumably entered the lake via the St. Clair-Detroit River System (Miller 1957).

Michigan

MH-1

Ocqueoc River (45°29', 84°04'). Spawning runs enter the Ocqueoc River (Hunn, pers. comm. 1979).

MH-4

Saginaw Bay (44°00', 83°30'). Gravid females are found near the Karn-Weadock Power Plant Complex (43°39', 83°51') in late June. Fry first appear in late June and are numerous at most stations by July-August (Beak Consult. 1976). Clupeid larvae are found in entrainment samples from mid-May to late August, and prejuveniles are found until late September; these may have been gizzard shad because most juveniles collected later were gizzard shad (Consumers Power 1976c,d). At the Quanicasse Power Plant site (43°35', 83°40'), gizzard shad larvae were collected during May-July and were more abundant than larvae of other species (Tex. Instrum. 1979b,e).

Ontario

OH-3

Baie du Dore (44°21', 81°34'). Larvae were collected here in June (Dunford 1978b).

GB-4

Colpoys Bay (44°47', 81°05'). Spawning runs enter Colpoys Bay and its tributaries (Moccia, pers. comm. 1979).

LONGJAW CISCO

The longjaw cisco is believed to be extinct in the Great Lakes and is now considered to be taxonomically synonymous with the shortjaw cisco (Todd and Smith, unpubl. data). The last capture of longjaw cisco in Lake Huron was recorded in Georgian Bay (45°30', 81°00') on June 12, 1975 (Todd 1978).

Ontario

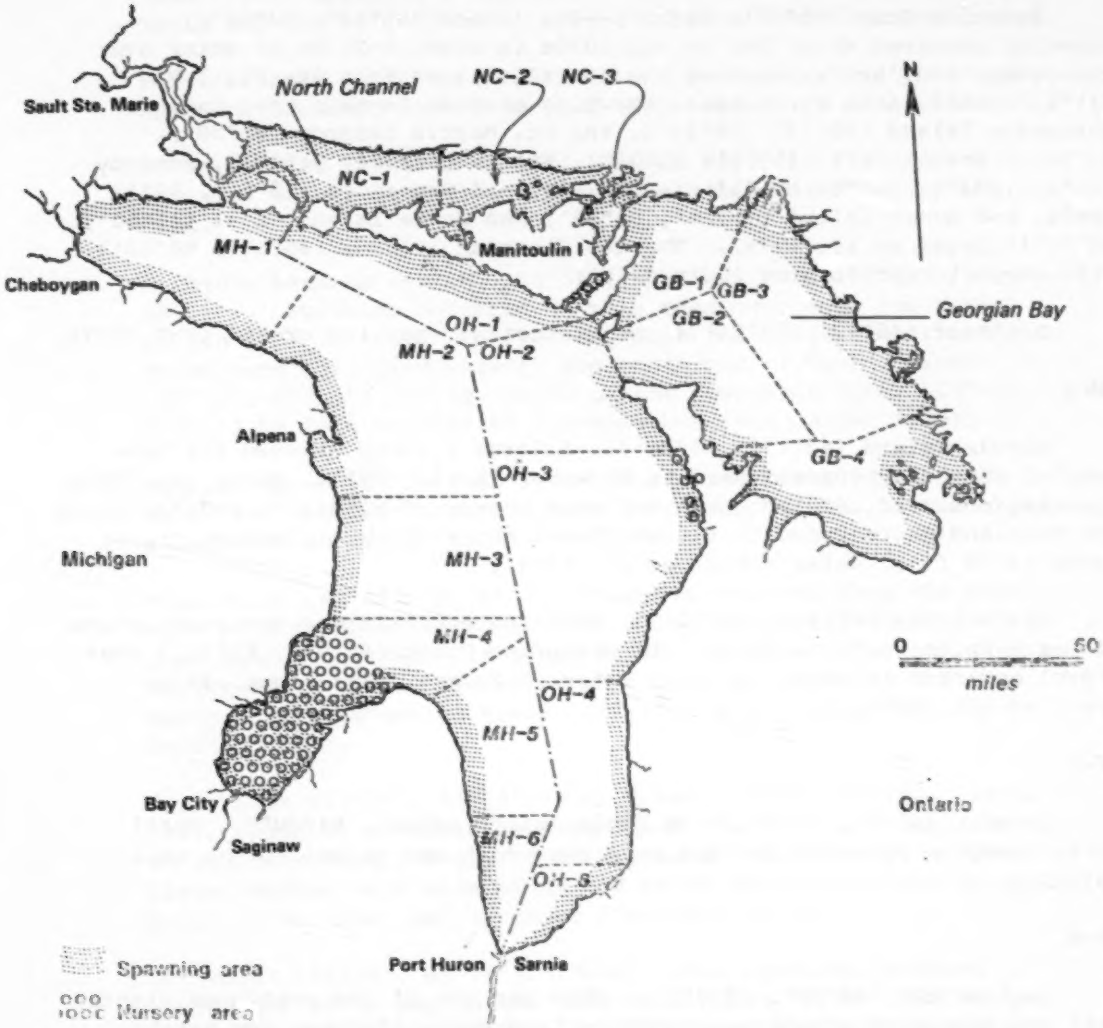
GB-4

Meaford (44°37', 80°35')--Cape Rich (44°43', 80°38'). An inshore spawning run moved into depths of 96-120 ft in this area (Koelz 1929).

Owen Sound (44°40', 80°53'). An inshore spawning run occurred here (Koelz 1929).

Colpoys Bay (44°47', 81°05'). Adults entered the bay in large numbers as early as the first week in November and spawned at depths of 60-144 ft. In 1919, the entire catch in late November and December was composed of spawning fish (Koelz 1929). In 1920, ripe females that had not yet spawned were caught on November 24 at Wiarton (44°45', 81°09) (Clemens 1922).

LAKE HERRING


Sault Ste. Marie
North Channel
NC-2
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Manitoulin I
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
OH-3
GB-4
Michigan
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0
60
miles
OH-4
MH-5
Ontario
Bay City
Saginaw
MH-6
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

The lake herring is generally declining in Lake Huron (Todd, pers. comm. 1981). Lake herring spawn in November and early December (Berst and Spangler 1970a; Carr 1962; Koelz 1926, 1929; Rathbun and Wakeham 1897). Runs of lake herring historically came inshore to spawn along the entire shoreline of the lake, usually over gravel and sand (Koelz 1929; Rathbun and Wakeham 1897).

Michigan

MH-1

Point De Tour (45°57', 83°55')--St. Ignace (45°52', 84°43'). Spawning occurred from 1946 to the 1970s in about 5-25 ft of water over honeycomb, mud, and sand along the shoreline area from St. Vital Bay (45°57', 83°59') to St. Ignace; spawning grounds in this area include Marquette Island (45°57', 84°23'), the St. Martin Islands (45°58', 84°36'), Beaver Tail (45°58', 84°09'), Martin (45°55', 84°09'), Pomeroy (45°55', 84°12'), Tobin (45°56', 84°12'), and Surveyors (45°57', 84°13') reefs, and Goose Island (45°55', 84°25') and Goose Island Shoal (45°54', 84°29') (Organ et al. 1978). The Les Cheneaux Islands (45°58', 84°20') also support reproduction (Odin 1979).

Poe Reef (45°42', 84°22'). An historical spawning ground (FWS 1977).

MH-2

Middle Island (45°11', 83°20'). A large fishery existed for lake herring when they spawned here in November (Koelz 1926). Since the 1930s, spawning occurred off the north and east shores of Middle Island and along the mainland shore opposite the southwest shore of the island on gravel areas in 10 ft of water (Organ et al. 1978).

Thunder Bay (45°00', 83°20'). Spawning occurs along the south shore of North Point (45°01', 83°16') to Whitefish Point (45°03', 83°21') over gravel and rock in about 30 ft of water (O'Gorman, pers. comm. 1979; Organ et al. 1978).

MH-3

Oscoda (44°25', 83°20')--Au Sable Point (44°20', 83°20'). Until 1946, spawning occurred in this area over rock and gravel (Organ et al. 1978).

MH-4

Saginaw Bay (44°00', 83°30'). This was one of the most consistently used and extensive spawning grounds in Lake Huron (Rathbun and Wakeham 1897) and was also a major fishing ground (MSBFC 1899); more than half of the total catch was taken in November (Hile and Buettner 1959). Lake herring disappeared from the bay in the late 1940s and early 1950s (Organ et al. 1978), but some spawning runs occurred in mid-November, at least until 1956 (Carr 1962). During the spawning season, the adults were collected at Point Lookout (44°03', 83°35'), Point Au Gres (43°59', 83°41'), Nayanquing Point (43°46', 83°56'), Tobico Marsh (43°42', 83°56'), Bay City (43°36', 83°52'), and Sand Point (43°55', 83°24') (Carr 1962; Van Oosten 1929). Spawning depended on temperature and occurred at depths of 25 ft or less anytime from late October to December (Organ et al. 1978). Young fish produced on spawning grounds in the bay probably spent most of their first year of life in the bay (Van Oosten 1927b).

Spawning areas within the bay (from Organ et al. 1978, unless otherwise specified) are as follows:

Au Sable Point (44°20', 83°20')--Point Lookout (44°03', 83°35'). Until 1946, spawning occurred throughout this area, including Tawas Bay (44°16', 83°30'), over a substrate of rock and gravel.

Point Lookout (44°03', 83°35')--Point Au Gres (43°59', 83°41'). Spawning occurred here from 1933-1935 over clay, sand, and rock.

Point Au Gres (43°59', 83°41')--Wigwam Bay (43°59', 83°50'). Spawning occurred until the mid-1950s over mud with clay and rock.

Gilman's Landing (43°48', 83°55')--Saginaw River (43°39', 83°51'). Spawning occurred in this area over sand and gravel (Organ et al. 1978). In 1921-23, fish that were almost ready to spawn were collected between the south end of Tobico Marsh (43°42', 83°56') and the mouth of the Kawkawlin River (43°40', 83°53') in late October to mid-November (Van Oosten 1929).

Saginaw River (43°39', 83°51')--Quanicasse River (43°35', 83°41'). Spawning occurred here over sand, gravel, and rock to a depth of about 12 ft.

Fish Point (43°43', 83°31'). Spawning occurred from the west side of Fish Point south to Sunset Bay Marina (43°40', 83°35') over sand along the 6 ft depth contour and over clay and sand at depths of 12-16 ft. Spawning also occurred directly off the mouth of the Sebewaing River (43°44', 83°28') along the 6 ft depth contour.

Sand Point (43°55', 83°24')--Oak Point (43°58', 83°16). Until 1947, spawning occurred over sand and rock out to a depth of 6 ft and over sand and gravel at depths of 12-24 ft. In 1908, large catches were made along the broad sand flat north of Sand Point in November and December (Leathers 1911).

Oak Point (43°58', 83°16'). Until 1946, spawning occurred around Oak Point and to the east to a point (44°00', 83°05') just past Hat Point (44°00', 83°07'), over rock and gravel to depths of 24 ft.

Point Lookout (44°03',83°35')--Little Charity Island (44°00', 83°28'). Until 1947, spawning occurred over rock, gravel, and sand in a crescent-shaped area at the 12-24 ft depth contours.

Coreyon Reef (44°00', 83°28'--43°40', 83°50'). In 1938-47, spawning occurred here over rock, sand, and gravel (Organ et al. 1978).

Ontario

OH-1

South Bay (45°38', 81°52'). Spawning may occur here; larvae were collected along shore in April and May (Faber 1970). In 1977, 60% of the larvae caught here were herring larvae (Loftus 1977). Herring and whitefish larvae appear simultaneously immediately after ice breakup. The larvae are distributed throughout the bay in the surface waters (Faber 1970).

OH-3

Stokes Bay (45°00', 81°23') and Pike Bay (44°52', 81°20'). These bays are nursery areas (Loftus 1977).

Fishing Islands (44°50', 81°22'--44°43', 81°20'). This area was one of the most extensive and consistently used spawning grounds (Rathbun and Wakeham 1897). In 1977, a few larvae were recovered in the area in late April to mid-May (Loftus 1977).

NC-2

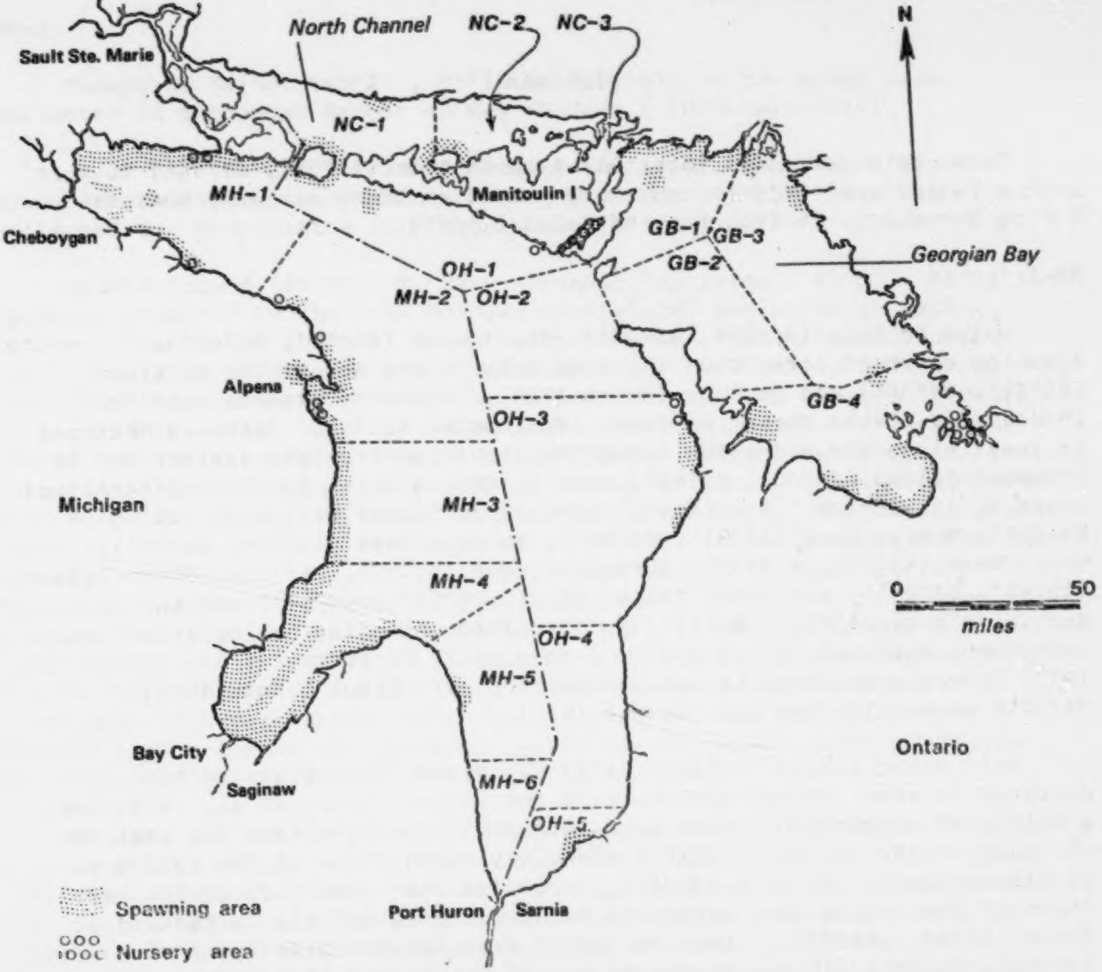
Aird (Cutler) Bay (46°11', 82°28'). Adults appeared in 12 ft of water around the islands in the bay by about November 10, remained for about 3 weeks to spawn, and then left abruptly (Koelz 1929).

GB-4

Bergie Point (44°45', 79°47'). A few larvae were collected from mid-April through May (Loftus 1977).

Colpoys Bay (44°47', 81°05'). The bay was an important "reserve" ground, which was closed to fishing and served as a sanctuary for natural reproduction (Ont. Game Fish 1932). Many "blueback" herring ran inshore during November in southern Georgian Bay (45°00', 80°30') (Bensley 1915).

LAKE WHITEFISH


North Channel
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NC-1
MH-1
Manitoulin I
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
OH-3
GB-4
Michigan
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MH-5
Ontario
Bay City
Saginaw
MH-6
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

In Lake Huron, lake whitefish spawn in November and early December (MacKay 1957f; Rathbun and Wakeham 1897). Lake whitefish prefer a limestone, honeycombed rock, and gravel substrate (Koelz 1929) but will spawn over sand and mud (FWS 1977). Spawning usually occurs in 36-48 ft of water (Koelz 1929). After hatching in mid-April, fry rise to the surface, remain for a few days, and then are carried or swim inshore where they concentrate in water less than 3 ft deep (Berst and Spangler 1970a, 1973). Larvae are encountered nearshore before or during the spring emergence of smelt fry and as late as early July (Reckahn 1970; Scott et al. 1978b).

Large spawning populations exist in northern Lake Huron (Eshenroder, pers. comm. 1980). In 1970, eggs were taken from spawning adults in northern Lake Huron on November 23, at a water temperature of about 42°F (Edsall and Rottiers 1976).

Michigan

Spawning occurred at intervals from De Tour (45°59', 83°54') to Port Austin (44°03', 83°00') in nearshore waters on rocky or sandy bottoms during November 1-25 (Rathbun and Wakeham 1897).

MH-1

Point De Tour (45°57', 83°55')--St. Ignace (45°52', 84°43'). Spawning occurred throughout the area between the Straits of Mackinac (45°49', 84°45') and De Tour (Geare 1884). Spawning grounds near St. Ignace were fished during November (Van Oosten 1927a). Spawning occurred at least since the mid-1960s along the shoreline from the eastern end of Drummond Island (46°00', 83°40') west to Grosse Point (45°58', 84°41') and south to St. Ignace. Specific sites include Beaver Tail Reef (45°58', 84°09'), Martin Reef (45°55', 84°09'), Pomeroy Reef (45°55', 84°12'), Tobin Reef (45°56', 84°12'), Surveyors Reef (45°57', 84°13'), Goose Island (45°55', 84°25'), and Goose Island Shoal (45°54', 84°29'), and the St. Martin Islands (45°58', 84°36'). Since 1965, spawning has occurred over honeycomb, rock, sand, and mud to depths of 24 ft (Organ et al. 1978). In 1973, larvae were found in small numbers at St. Vital Point (45°57', 84°00') on May 30-June 1 (O'Gorman 1975).

Bois Blanc Island (45°46', 84°27'). Since 1965, spawning has occurred in areas around the shore of the island (Organ et al. 1978) over a bottom of honeycombed rock, sand, and mud. One area from the east end of Round Island (45°50', 84°36') along the north shore of the island to Lighthouse Point (45°49', 84°25'). Spawning also occurs along the east shore of the island from Lafayette Point (45°46', 84°21') to Packard Point (45°43', 84°25'). Lake whitefish also spawned over Poe Reef (45°42', 84°22') off the southeast tip of the island (FWS 1977).

Spectacle Reef (45°46', 84°08'). A few ripe fish were collected here (Rathbun and Wakeham 1897).

Cheboygan (45°39', 84°28')--Hammond Bay (45°30', 84°05'). Since 1945, spawning has occurred from Duncan Bay (45°39', 84°26') at Cheboygan Point (45°40', 84°26') to the Hammond Bay Biological Station (45°30', 84°02') at depths to about 50 ft from late October to mid-November. Substrate included aquatic vegetation from Duncan Bay to Nine Mile Point (45°38', 84°13') and rock, gravel, and sand in the Hammond Bay area (O'Gorman, pers. comm. 1979; Organ et al. 1978). A spawn collecting station was located at Nine Mile Point (Clark 1886). Spawning occurred from mid-November to early December in Hammond Bay (Van Oosten 1927a).

Eggs were collected from spawners in Hammond Bay for propagation (Clark 1886). In 1973, a few fry were collected in the bay on May 30-June 1 (O'Gorman 1975).

MH-2

Thompsons Harbor (45°21', 83°36'). In 1973, a few young were collected in Thompsons Harbor on May 30-June 1 (O'Gorman 1975).

North Bay (45°21', 83°30'). During the 1930s, lake whitefish spawned here over honeycombed rock (Organ et al. 1978). Spawn was collected for propagation at Presque Isle (45°21', 83°29') (Clark 1886).

Middle Island (45°11', 83°20')--Thunder Bay Island (45°03', 83°12'). Spawning occurred in the area between the islands beginning in late October (Van Oosten 1927a). Spawning occurred at Middle Island during the 1930s-1970s off the east side of the island over gravel and during the 1930s off the north side of the island over unknown substrate (Organ et al. 1978). A few lake whitefish larvae were collected off Rockport (45°12', 83°23') in June 1975 (O'Gorman 1978). During the 1970s, whitefish spawned in an area extending 3-8 mi offshore between South Nine Mile Point (45°08, 83°19') and Potter Point (45°05', 83°18') over a gravel shoal at depths of 24-30 ft (Organ et al. 1978). This was one of the best whitefish spawning areas (Koelz 1929), where whitefish appeared in "countless numbers" in November (Smith and Snell 1891). Spawn collecting stations were located at Round Island (45°05', 83°18') and Sugar Island (45°03', 83°14') (Clark 1886). Spawning occurred in 1957-68 around Thunder Bay Island and during the 1920s-1960s towards shore along the south edge of Sugar Island (Organ et al. 1978). Lake whitefish were heavily fished during the spawning season on the shoals north of Thunder Bay Island and Sugar Island (Smith and Snell 1891).

Thunder Bay (45°00', 83°20'). During the 1880s, eggs were collected from ripe lake whitefish in Thunder Bay (Berst and Spangler 1970a; Clark 1886; U.S. Comm. Fish Fish. 1885); spawning occurred during November 5-20 (Van Oosten 1927a) and peaked November 10-15 (Geare 1884). Spawning is especially successful in the North Point area (45°01', 83°16') (FWS 1979d). One gravel and rock area extends from North Point to Whitefish Point (45°03', 83°21') (O'Gorman, pers. comm. 1979; Organ et al. 1978) and a second extends southeast over the gravel shoal off North Point (Organ et al. 1978). Lake whitefish spawned at Alpena (45°04', 83°26') (MSBFC 1890) and still congregate in large numbers on the reefs near Alpena (Hile, pers. comm. 1979), primarily those already discussed north of North Point. Records from the late 1800s state that the catch was declining and many of the spawning beds had been destroyed by sawdust and mill and rafting refuse (MSBFC 1888, 1890, 1895). A run into the Thunder Bay River (45°04', 83°26') was wiped out by 1925 due to sawmill waste (Schneider and Leach 1979). Historically, few adults were caught during the spawning season along the west and north shores of the bay (Smith and Snell 1891), but commercial fishermen have recently identified spawning areas along the north shore that have been used since the 1920s (Organ et al. 1978). The gravel shoals off the east side of Sulphur Island (44°59', 83°25') are currently used (Organ et al. 1978), and the area around Scarecrow Island (44°55', 83°20') was heavily fished during the spawning season (Clark 1886; Ravenel 1898; Smith and Snell 1891). In May 1975, a few whitefish larvae were collected off Alpena (O'Gorman 1978).

MH-3

Thunder Bay (45°00', 83°20')--Saginaw Bay (44°00', 83°30'). Spawning occurred from Alpena (45°04', 83°26') to Saginaw Bay (Van Oosten 1927a). Commercial fishermen have recently identified the entire shoreline from North Point (45°01', 83°16') to Au Sable Point (44°20', 83°20') as a spawning ground. The earliest recorded catch of spawners was in the 1920s over a substrate of gravel, rock, clay, and mud (Organ et al. 1978). In the 1880s, spawning occurred off Alcona (44°45', 83°18'), where spawn was collected, and off Sturgeon Point (44°43', 83°16') (Berst and Spangler 1970a; Clark 1886). Seven Mile Point (44°33', 83°18') was described as a fair spawning ground (MSBFC 1895). Lake whitefish were abundant along the entire shore of Iosco County (44°31', 83°19'--44°10', 83°34') during the spawning season (Smith and Snell 1891). Spawning occurred off Millers Point (44°30', 83°19') about 6 mi north of Oscoda (44°25', 83°20') on November 15-20 (Van Oosten 1927a). By 1895, mill refuse and sawdust had reportedly driven the lake whitefish away from the Oscoda--Au Sable area (MSBFC 1895).

MH-4

Saginaw Bay (44°00', 83°30'). Most of the shoreline, island, and reef areas of Saginaw Bay were used by whitefish for spawning. The entire bay was a fishing ground during the spawning season, usually in November, but sometimes as early as October (Koelz 1929; Van Oosten 1927a); fishermen collected eggs here for hatcheries located at Bay City (43°36', 83°52') and Bay Port (43°51', 83°22') (Westerman 1928, 1930, 1933).

> Au Sable Point (44°20', 83°20')--Point Lookout (44°03', 83°35'). From 1915 to the present, spawning occurred along the shoreline between these points over gravel, rock, and sand (Organ et al. 1978). Spawning occurred in Tawas Bay (44°16', 83°30') as early as October and as late as mid-December; at Point Lookout, spawning began on about November 20 (Van Oosten 1927a). Lake whitefish also spawned in large numbers at Gravelly Point (possibly Gravelly Shoal, 44°02', 83°33') (Geare 1884).
>
> Point Au Gres (43°59', 83°41')--Saganing Bar (43°55', 83°51'). This region is an historical spawning area; spawning was last reported in 1952 (Organ et al. 1978). Spawning at Rifle Bar (43°58', 83°43') began on about November 15 (Van Oosten 1927a).
>
> Pinconning Bar (43°51', 83°52')--Quanicasse (43°35', 83°40'). Pinconning Bar, Ne'Oquam Point (possibly Nayanquing Point, 43°46', 83°56'), and the head of Saginaw Bay were historic

spawning areas (Van Oosten 1927a). Spawning occurred during the 1930s on a sand and gravel area extending from Gilmans Landing (43°48', 83°55') to Quanicasse (Organ et al. 1978).

Fish Point (43°43', 83°31')--Hat Point (44°00', 83°07'). Spawning occurred west of Fish Point at depths of 14-16 ft; in 1915-77 from south of Fish Point to Heisterman Island (43°51', 83°26') over rock and sand at a depth of 6 ft; in 1938-78 in a small area northwest of North Island (43°53', 83°25') at depths of 12-14 ft; in 1938-78 on a small sand area north of the tip of Sand Point (43°55', 83°24'); from 1917-1960s on the reef area northwest of Sand Point (at 43°56', 83°27') at depths of 5-6 ft; in 1915-78 along the shoreline from Sand Point, around Oak Point (43°58', 83°16') over rock, gravel, and sand; and in 1938-79 from Oak Point to about 2 mi E of Hat Point (44°00', 83°05') over rock, sand, and gravel (Organ et al. 1978). In the early 1900s, whitefish spawned on the broad sand flats off Sand Point (Leathers 1911).

Charity (44°02', 83°26') and Little Charity (44°00', 83°28') Islands. Since the late 1800s, the rock and gravel areas around the islands were used extensively for spawning (Geare 1884; Organ et al. 1978). Spawning occurred during November (Van Oosten 1927a).

Coreyon Reef (44°00', 83°28'--43°40', 83°50'). Spawning occurred during November along the reef, from the Charity Islands to Bay City (43°36', 83°52') (Van Oosten 1927a).

Huron City (44°02', 82°50'). Spawning occurs at a small rocky area at depths of 6-30 ft (Organ et al. 1978).

MH-5

Harbor Beach (43°51', 82°39'). Spawning occurred here (Hile, pers. comm. 1979).

MH-6

Forester (43°30', 82°34'). In 1890, Honeycomb Reef, or Rock, 6 mi E of Forester, was a recommended site for lake whitefish planting (MSBFC 1890); it was not stated that this was a spawning area.

Port Huron (43°00', 82°26'). Spawning occurred along shore at depths of 30-50 ft (Organ et al. 1978).

Ontario

Spawning grounds in the Canadian waters of Lake Huron, and especially those in Georgian Bay (45°30, 81°00'), were degraded by discharges of sawdust and bark from log rafts which formed dense mats on the bottom (Rathbun and Wakeham 1897). Spawning occurs in the lake proper on November 20-December 10 and in Georgian Bay on November 10-December 15 (MacKay 1969).

OH-1

Cockburn Island (45°55', 83°20'). Lake whitefish were reported to come onshore to spawn around November 10 (Ont. Game Fish 1913a).

Manitoulin Island (45°50', 82°30'). Lake whitefish spawned in shallow water over honeycombed rock which extended some distance from the south shore of the island (Bell 1895). Lake whitefish spawned around the Duck Islands (45°43', 82°56') (Rathbun and Wakeham 1897). In 1965-1969, young lake whitefish and young round whitefish were caught in Michael Bay (45°35', 82°06') over a sandy bottom at a depth of about 12 ft in mid-July; the water temperature there was about 63°F (Reckahn 1970). Ripe adults were caught on the rocky shoals in South Bay (45°38', 81°52'), primarily at the northeast end of the inner basin in mid-November (Faber 1970; Reckahn 1970). Spawning occurred along shore in the shallows, and hatching occurred in April (Berst and Spangler 1970a; Collins 1975; Faber 1970; Reckahn 1970). In 1977, larvae were collected in the bay (Loftus 1977). Newly hatched larvae were found along shore over rubble and gravel, usually at depths less than about 30 ft for 2-3 weeks in April-May after ice breakup (Faber 1970). Larvae were found in less than 3 ft of water adjacent to areas of emergent vegetation in June and early July (Reckahn 1970). The young moved into the metalimnion at depths of about 47-50 ft in July and August and then into deeper, colder water (Berst and Spangler 1970a; Reckahn 1970). Fry were found in South Bay at Fair's Rock (location uncertain) in April and May (Collins 1975).

OH-3

Fishing Islands (44°50', 81°22'--44°43', 81°20'). Spawning occurred among the islands (Rathbun and Wakeham 1897). In 1977, larvae were collected here from late April to mid-May; Stokes Bay (44°59', 81°23') and Pike Bay (44°52', 81°20') were identified as nursery areas (Loftus 1977).

Southampton (44°30', 81°22'). Spawning occurred near Southampton (Rathbun and Wakeham 1897).

OH-5

Cape Ipperwash (43°13', 82°00'). A few fish spawned in the Cape Ipperwash vicinity (Rathbun and Wakeham 1897) and northeast of Kettle Point (43°13', 82°01') (Ont. Game Fish 1909).

NC-1

Thessalon River (46°15', 83°33'). This may be a spawning ground (MacDonald 1978).

Blind River (46°11', 82°57'). In 1917, spawning occurred at Blind River on November 8 (Koelz 1929).

NC-2

There were extensive spawn taking operations in the North Channel (Ont. Game Fish 1913a, 1939) and at Little Current (45°59', 81°56') (Ont. Game Fish 1943).

Barrie Island (45°55', 82°40'). In 1917, spawning occurred on November 10 (Koelz 1929).

GB-1

Spawning occurred in the inshore waters of the north shore of Georgian Bay (Ont. Game Fish 1931).

Squaw Islands (45°50', 81°27'). Spawning occurs among the Squaw Islands and associated reefs (Rathbun and Wakeham 1897).

GB-3

Bustard Islands (45°53', 80°55'). Spawning occurred among the islands and associated reefs in November (Rathbun and Wakeham 1897).

French River (45°56', 80°54'). Eggs were collected from ripe fish (Rodd 1914, 1917, 1918). Spawning occurred at the river mouth in early November (Kerr and Kerr 1860-1898).

Byng Inlet (45°46', 80°38'). This is a major spawning ground (Budd 1957). Spawning occurred here about November 10 (Kerr and Kerr 1860-1898).

Western Islands (45°04', 80°20'). Spawning occurred among the islands and associated reefs in November (Rathbun and Wakeham 1897).

GB-4

Matchedash Sound (44°50', 79°50'). In 1977, lake whitefish larvae were collected in April (Loftus 1977).

Nottawasaga Bay (44°40', 80°15'). Lake whitefish spawned in many areas of the bay including Gridley (Gidley) Point (44°45', 80°07'), Spratt Point (44°36', 80°01'), the mouth of the Nottawasaga River (44°33', 80°00'), Collingwood (44°30', 80°13'), the Mary Ward Ledges (44°34', 80°19'), Clay Banks (44°36', 80°33'), and Woodland Beach (location unknown) (Cucin and Regier 1966; Kerr and Kerr 1860-1898). A discrete population spawns near the south end of Wasaga Beach (44°31', 80°02') (GLFC 1961). Whitefish may have spawned at Thornbury (44°34', 80°27') (Ont. Game Fish 1911, 1912).

Owen Sound (44°40', 80°53')--Wiarton (44°45', 81°09'). Lake whitefish spawned throughout this area (Ont. Game Fish 1916, 1932). Spawning occurred at Hay (44°53', 80°58'), White Cloud (44°50', 80°58'), and Griffith (44°50', 80°54') islands, and Cape Commodore (44°48', 80°54') (Cucin and Regier 1966).

Lake whitefish in southern Georgian Bay move from deep water to inshore shoals to spawn (Bensley 1915). Fishermen caught lake whitefish on spawning grounds in this area from late October to early December, at depths as shallow as 6-12 ft (Cucin and Regier 1966).

BLOATER

In Lake Huron, bloaters may spawn throughout the year (Koelz 1929), but spawning usually occurs in February and March (Lagler 1948). Bloaters are generally common but locally declining in some areas of Lake Huron (Todd, pers. comm. 1981). Very few areas have been identified as sites of reproduction.

MH-1

St. Vital Point (45°57', 84°00'), St. Martin Bay (46°00', 84°37'), and Hammond Bay (45°30', 84°05'). During a 1973-1975 survey conducted in the U.S. waters of the lake, bloater larvae were found only in the northern portion of the lake. Larvae usually are found only in the deeper waters, but some were occasionally taken in shallow, nearshore waters in St. Martin Bay at St. Vital Point, and in Hammond Bay; these larvae may have been carried into shallow water by the periodic upwelling of deeper, offshore water along these shorelines (O'Gorman 1975, 1978).

MH-3

Oscoda (44°25', 83°20'). Spawning probably occurred 10 mi E of Oscoda; eggs and sperm stripped from ripe males and females collected there in February 1967 produced fertilized eggs that hatched and yielded viable larvae (Edsall et al. 1970).

MH-5

Harbor Beach (43°51', 82°39'). Spawning may have occurred near Harbor Beach, where spent females and pearled males were taken in mid-March 1919 (Koelz 1929).

DEEPWATER CISCO

The deepwater cisco is probably extinct in Lake Huron. The last capture in Lake Huron was recorded at Wolfsell, Ontario, on August 4, 1952 (Todd 1978).

Michigan

MH-2

Alpena (45°04', 83°26'). In 1919, a few fish that were ready to spawn, running, or spent were caught on August 30 and September 3. In 1920, many females that were nearly ripe were caught on August 7 (Koelz 1929).

Ontario

GB-2

Georgian Bay (45°30', 81°00'). Fish apparently congregated off the Saugeen, or Bruce, Peninsula (45°00', 81°20') at depths of 360 ft over a mud bottom during September; catches at this time near Lion's Head (45°00', 81°13') and Tobermory (45°15', 81°40') nearly doubled, and many of the fish were running ripe (Koelz 1929).

KIYI

The kiyi is probably extinct in all the Great Lakes except Lake Superior, where its numbers are declining and its status is threatened (Todd, pers. comm. 1981). The last capture in Lake Huron was recorded at Griffith Island (44°50', 80°54'), in Georgian Bay (45°30', 81°00'), on July 10, 1973 (Todd, 1978). Kiyi probably spawned in October or November in Lake Huron (Koelz 1929; Lagler 1948), but the spawning grounds were not described.

BLACKFIN CISCO

The blackfin cisco is believed to be extinct in all the Great Lakes (Todd, pers. comm. 1981). The last capture in Lake Huron was recorded in Colpoys Bay (44°47', 81°05') at Wiarton (44°45', 81°09') on June 26, 1923. In Lake Huron, the blackfin did not spawn before November (Koelz 1929) and possibly not until January. Spawning occurred at depths of about 360 ft (Berst and Spangler 1970a), but no spawning areas were identified.

SHORTNOSE CISCO

Ontario

The shortnose cisco is believed to be extinct in the Great Lakes, with the exception of a small population in Georgian Bay (45°30', 81°00'), Lake Huron. It is an endangered species and may be extinct within the next several years (Todd, pers. comm. 1981). No information was found concerning spawning and nursery grounds.

SHORTJAW CISCO

The shortjaw cisco is believed to be extinct in Lake Huron and is now considered to be taxonomically synonymous with the longjaw cisco (Todd 1978; Todd and Smith, unpubl. data). The last capture of shortjaw cisco in Lake Huron was recorded at Tawas City (44°16', 83°31'), Michigan, on September 16, 1956 (Todd 1978).

Michigan

MH-1

Spectacle Reef (45°46', 84°08')--Forty Mile Point (45°29', 83°55'). Adults congregated in this area over a clay bottom in mid-September, first at depths of about 180 ft and then at depths of 240-300 ft, where they spawned. Males with pearl organs, fully ripe females, and later spent females were caught. Fishing for this species took place during September and October; spawning apparently ended in early October, when catches dropped dramatically (Koelz 1929).

MH-5

The shortjaw cisco also may have spawned in the southern part of Lake Huron because small ones (no age given) were caught at Harbor Beach (43°51', 82°39') in March 1919 (Koelz 1929).

CISCO spp.

Michigan

MH-1

Point De Tour (45°57', 83°55')--Pomeroy Reef (45°55', 84°12'). Since 1962, spawning has occurred in an area (45°53', 83°56'--45°53', 84°12') over mud at depths of 120-300 ft (Organ et al. 1978).

Bois Blanc Island (45°46', 84°27'). Spawning occurs off the northeast corner of the island (45°49', 84°25'--45°48', 84°15') over mud and clay at depths of 120-300 ft (Organ et al. 1978).

Spectacle Reef (45°46', 84°08')--Hammond Bay (45°30', 84°05'). Spawning occurs at an unnamed area (45°45', 84°05'--45°35', 84°00') over mud and clay at depths of about 120-300 ft (Organ et al. 1978). This is the same location cited by Koelz (1929) as a spawning ground for the shortjaw cisco.

MH-2

Black Point (45°21', 83°32'). Spawning occurs in an area northwest (45°22', 83°34') of Black Point over mud at depths of about 60-100 ft during November (Organ et al. 1978).

MH-3

Black River (44°49', 83°18')--Sturgeon Point (44°43', 83°16'). In 1959-64, chubs spawned throughout the area (44°49', 83°13'--44°43', 83°16') at a depth of about 100 ft during November (Organ et al. 1978).

Six Fathom Bank (44°49', 82°30'). Spawning occurs off the north point of the bank (Organ et al. 1978).

MH-4

Port Austin (44°03', 83°00')--Huron City (44°02', 82°50'). Spawning occurred in an area (44°11', 82°57'--44°07', 82°48') over steep banks with mud bottoms at depths greater than 180 ft during November and December (Organ et al. 1978).

MH-5, MH-6

Port Hope (43°57', 82°43')--Lexington (43°16', 82°32'). Spawning occurs in the entire area (43°57', 82°35'--43°18', 82°25') over mud at depths of about 50-200 ft (Organ et al. 1978).

Ontario

OH-3

An unidentified species of chub spawned northwest of Southampton (44°30', 81°22') (Koelz 1926).

PINK SALMON

Since this species was accidentally released in 1956 into Canadian waters of Lake Superior, self-sustaining populations have spread throughout the Great Lakes (Wagner 1979). The first reported capture of pink salmon in Lake Huron occurred in 1969 (Wagner 1974a). Spawning runs enter Lake Huron tributaries in September, and spawning usually occurs over the first suitable gravel near the stream mouth (Wagner 1974a, 1976a,b). Pink salmon have been reported along the U.S. shore as far south as Port Sanilac (43°26', 82°32') (Wagner 1979).

Michigan

MH-1

Albany Creek (45°58', 84°05'). Spawning runs first occurred here in September 1973 and have continued through 1979 (Wagner 1974a, 1976a,b, 1977).

Carp River (46°02', 84°41'). The first record of pink salmon in Lake Huron was established in 1969 when one spent female was observed in this river (Collins 1975b, Wagner 1974a). Runs were recorded here in 1973, 1977, and 1979 (Wagner 1977, 1979). In 1973, the run occurred in late September-early October (Wagner 1974a).

Cheboygan River (45°39', 84°28'). Runs began in 1977 (Wagner 1977) and have continued through 1979 (Wagner 1979). Runs may also occur in many other streams in Cheboygan County (North Woods Call 1979j).

Ocqueoc River (45°29', 84°04'). The first run into a tributary in Michigan's lower peninsula occurred here in 1975 (Wagner 1976a,b), and runs have continued to the present (Hunn, pers. comm. 1979; Wagner 1979). Runs may occur in other streams of Presque Isle County (45°37', 84°12'--45°13', 83°24') (North Woods Call 1979j).

MH-3

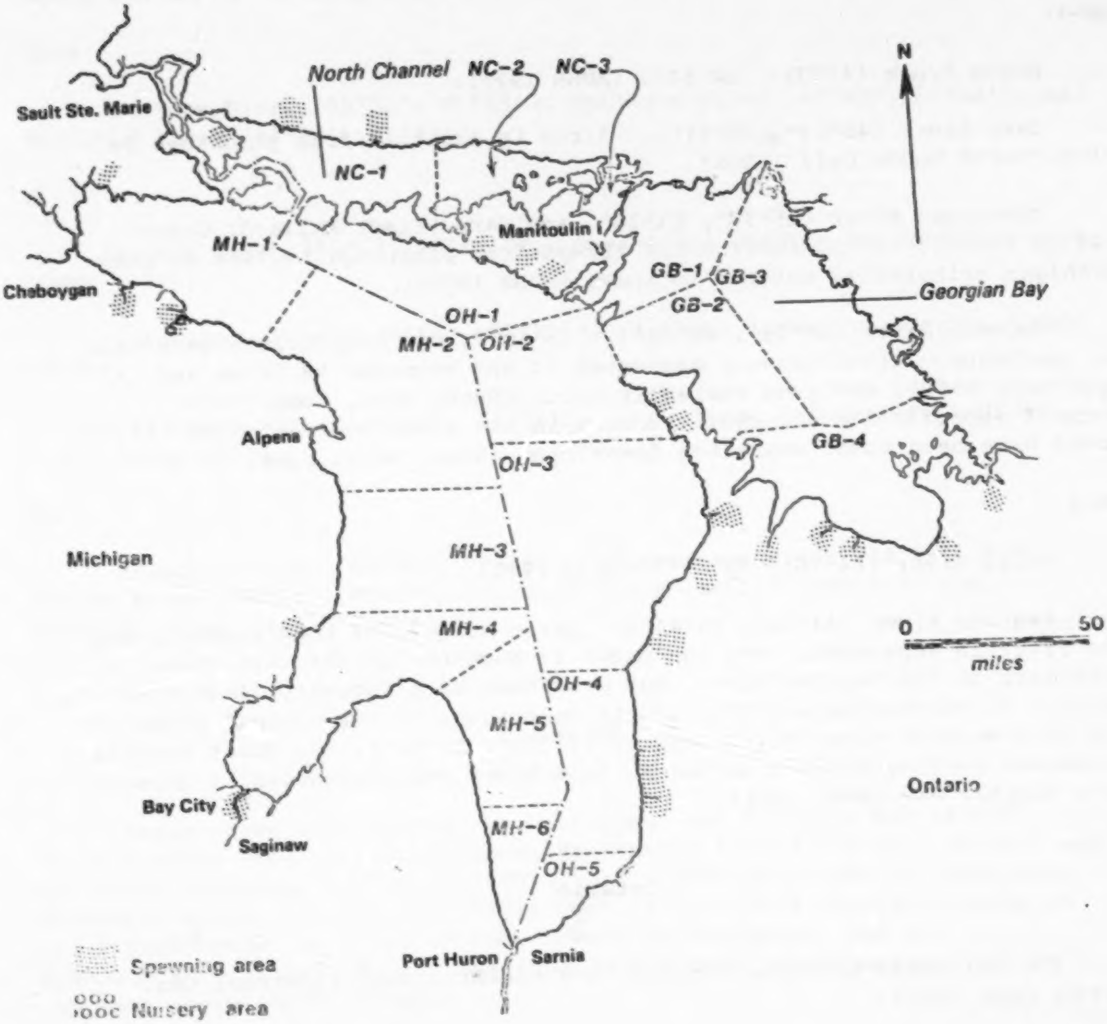
Au Sable River (44°24', 83°19'). One fish was reported here in 1977 (North Woods Call 1979j), and in 1979 pink salmon were listed as common (Wagner 1979).

Ontario

OH-1

Mindemoya River (45°40', 82°16'). In 1973, redds and spawning fish were observed on October 2, spawning ended on about October 9, and eggs in the redds hatched by November 27. Fry subsequently emerged from the gravel during April 8-29, and peak emergence occurred on April 18 (Collins 1975b).

COHO SALMON


North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
Manitoulin I.
MH-1
GB-1
GB-3
Georgian Bay
GB-2
Cheboygan
OH-1
MH-2
OH-2
Alpena
GB-4
OH-3
Michigan
MH-3
0
50
miles
MH-4
OH-4
MH-5
Ontario
Bay City
MH-6
Saginaw
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

In 1967, coho salmon were first stocked in many Lake Huron tributaries (GLFC 1973, 1975, 1976, 1978; MDNR 1970; Parsons 1973), and spawning runs enter tributary streams to spawn in the fall, usually after September (FWS 1979d).

Michigan

The following streams have spawning runs from plantings or straying.

MH-1

Nunns Creek (46°02', 84°34') (MDNR 1970).

Carp River (46°02', 84°41'). A run is expected from plantings in 1979 (North Woods Call 1980a).

Cheboygan River (45°39', 84°28') and Carp (Black Mallard) Creek (45°32', 84°07'). In 1967, a few strays from plantings in 1966 in Lake Michigan tributaries entered to spawn (MDNR 1970).

Ocqueoc River (45°29', 84°04'). In 1969, six coho salmon were seen in the Ocqueoc River between September 13 and November 18 (King and Applegate 1969), and runs currently occur (Hunn, pers. comm. 1979). Natural reproduction apparently occurs in the river because young (4-6 in. long) have been found migrating downstream (Hunn, pers. comm. 1979).

MH-4

Tawas River (44°16', 83°31') (Tody 1970).

Saginaw River (43°39', 83°51'). Large schools of coho salmon enter the river in September. The run peaks in November in the Cass River, a tributary of the Saginaw River, but continues into February (Beak Consult. 1976). In mid-September 1972, adults were found in the thermal plume of the Karn-Weadock Power Plant Complex (43°39', 83°51'); the plant complex withdraws cooling water from the Saginaw River and discharges it directly into Saginaw Bay (MWRC 1974).

Ontario

The following Canadian streams have spawning runs (Environ. Can. 1977c; OMNR 1973):

OH-1

Srigley Creek (45°43', 82°29'), Mindemoya River (45°40', 82°16'), and Manitou River (45°36', 82°06').

OH-2

Willow Creek (45°10', 81°34') and Spring Creek (45°02', 81°27').

OH-3

Sauble River (44°40', 81°17'), Saugeen River (44°30', 81°23'), and South and North Penetangore and Kincardine Creek (44°11', 81°39').

OH-4

Lucknow River (43°53', 81°43'), Maitland River (43°45', 81°44'), and Bayfield River (43°34', 81°43').

NC-1

Jaggers Creek (46°15', 83°53'). Occasional catches may indicate runs (OMNR 1976b).

Livingstone Creek (46°15', 83°29'). A small annual run occurs (OMNR 1976b).

Mississagi River (46°10', 83°01'). Occasional catches may indicate runs (OMNR 1976b).

GB-4

Sturgeon River (44°44', 79°44'), Nottawasaga River (44°33', 80°00'), Beaver River (44°34', 80°27'), Bighead River (44°37', 80°35'), and Sydenham River (44°35', 80°56').

KOKANEE

Kokanee have been stocked in Lake Huron and Georgian Bay (45°30', 81°00') since 1964, primarily along Manitoulin Island (45°50', 82°30') and the Bruce Peninsula (45°00', 81°20'), and significant spawning runs have developed since 1966 (Collins 1971; OMNR 1973). Runs generally begin in mid-August, peak the third or fourth week of September, and end by mid-October (Collins 1971). Spawning occurs both in tributaries and on the lake shore (GLFC 1970a).

Ontario

Runs have been reported in the following tributaries of the Bruce Peninsula (45°00', 81°20') and Manitoulin Island (45°50', 82°30'), where spawning occurs in September (OMNR 1973).

OH-1

Mindemoya River (45°40', 82°16') (Environ. Can. 1977c).

Jenkins Creek (45°37', 82°12) (OMNR 1973).

Manitou River (45°36', 82°06') (Environ. Can. 1977c). Major runs began here in 1967 (GLFC 1968).

Bluejay Creek (45°35', 82°05'). Major runs began here in 1967 (GLFC 1968). In 1970-71, the run began in late August-early September, three periods of peak movement occurred during September, and the run ended in early October. Most spawning occurred over fine gravel at the headwaters about 10 mi above the mouth, when water temperatures were about 46-61°F. Alevins and fry emerged from the redds in early January-late May in spring-fed headwater areas, and in late April-late May in other portions of the river. Young migrated out of the stream in late January-late May; 55% of the escapement occurred under ice from late January through mid-March. Peak movement occurred in mid-March and again in early May (Collins 1971; Porter 1972).

South Bay (45°38', 81°52'). A large shoreward movement occurs here prior to spawning (Collins 1971; Reckahn 1970). In 1969, most spawning began in late September, peaked October 2, and ended by October 15. Eggs were found in redds October 14 and November 5 (Collins 1971).

OH-2

Willow Creek (45°10', 81°34') (Environ. Can. 1977c).

OH-3

Saugeen River (44°30', 81°23') (Environ. Can. 1977c).

GB-2

Judges Creek (44°58', 81°13') (Environ. Can. 1977c).

GB-4

Sturgeon River (44°44', 79°44'). In 1968, spawning was observed about 2 mi above the river mouth in the fall (Thede 1970).

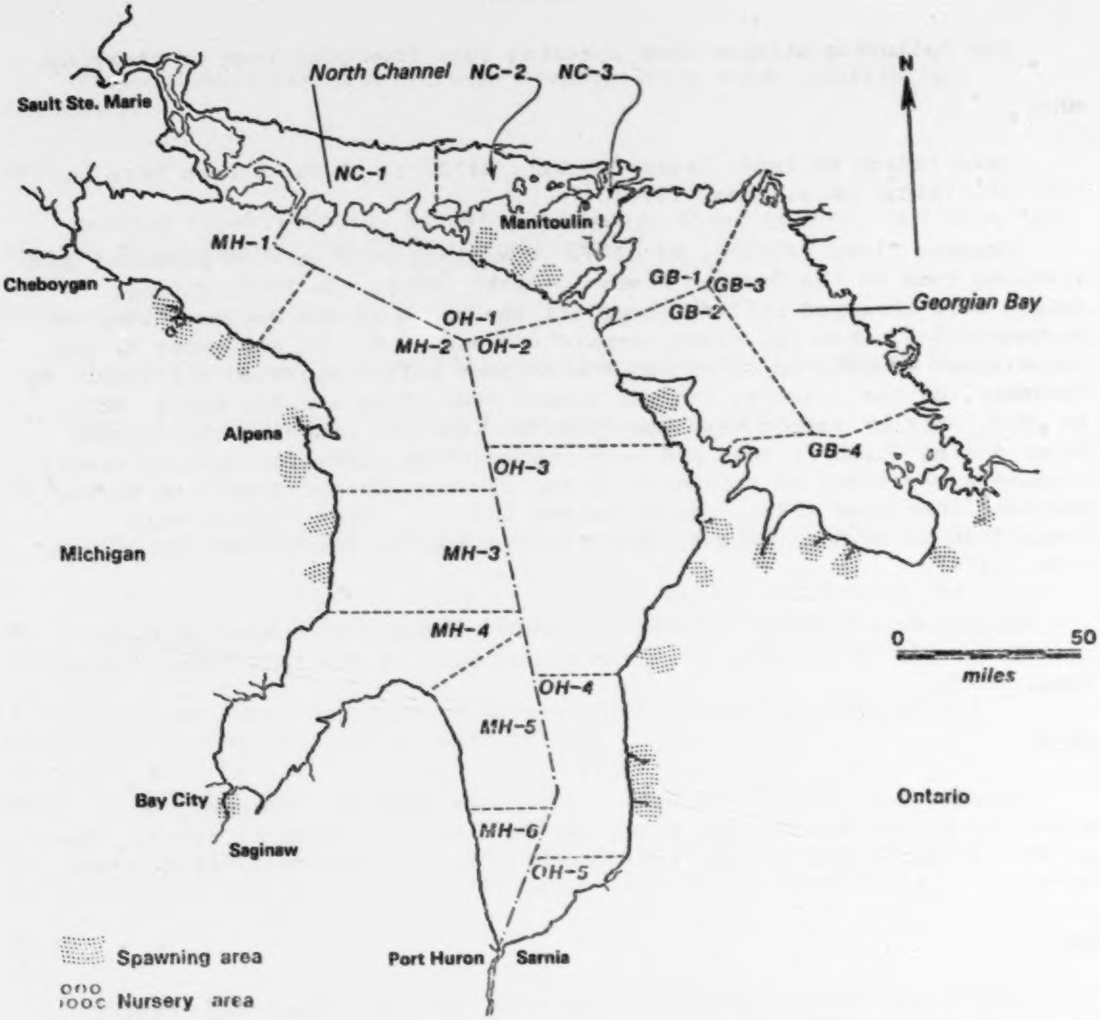
Bighead River (44°37', 80°35') (OMNR 1973).

Telfer Creek (44°38', 80°52'), Sydenham River (44°35', 80°56'), Pottawatomi River (44°35', 80°56') (Environ. Can. 1977c).

Gleason Brook (Oxenden Creek) (44°46', 81°06') (Collins 1971; Environ. Can. 1977c). Major runs began in 1967 (GLFC 1968).

Colpoys Creek (44°47', 81°07') (Collins 1971; Environ. Can. 1977c).

CHINOOK SALMON


North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
Manitoulin I
MH-1
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
OH-3
GB-4
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Ontario
Bay City
MH-6
Saginaw
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

In 1873, chinook salmon were introduced into U.S. waters of Lake Huron, however, self-sustaining populations were not established (Parsons 1973). In 1967, chinook salmon were reintroduced into U.S. waters of Lake Huron (GLFC 1973, 1975, 1976, 1978; MDNR 1970; Parsons 1973) and produced spawning runs in many of the lake's tributaries in the fall (FWS 1979d); self-sustaining populations are established in some areas.

Michigan

The following streams have spawning runs from plantings or straying.

MH-1

Carp (Black Mallard) Creek (45°32', 84°07'). A run occurs here in the fall (King, pers. comm. 1979).

Ocqueoc River (45°29', 84°04'). Plantings made in 1968 produced good spawning runs in the Ocqueoc River (Rybicki 1973). In 1969, chinook salmon were observed milling about off the mouth of the Ocqueoc River on September 5-7, when the river temperature was 70°F. On September 8, the temperature dropped to 65°F, and the chinook salmon migrated upstream. By November 18, the spawning run was almost over (King and Applegate 1969). In 1970, chinook salmon were concentrated near the mouth of the Ocqueoc River during October; they had been congregating there for several weeks because a barricade at the mouth of the river prevented them from moving upstream (Reynolds 1970). Young salmon (3-4 in. long), tentatively identified as chinook salmon, were found migrating downstream (Hunn, pers. comm. 1979).

Nagels Creek (45°27', 83°52'). Adults attempt to enter the creek. Swan River (45°24', 83°44'). A run occurs here in the fall (Hunn, pers. comm. 1979).

MH-2

Thunder Bay (45°00', 83°20'). Plantings made in 1968 produced a minor run in the Thunder Bay River (45°04', 83°26') (Rybicki 1973). There is also a run in the Devils River (44°55', 83°25') (Stedman, pers. comm. 1979).

MH-3

Mill Creek (44°40', 83°17'). In 1979, chinook salmon were caught while schooling off Harrisville (44°40', 83°18') in late August. Au Sable River (44°24', 83°19'). During late August 1979, chinook salmon were observed schooling off the mouth of the Au Sable River (Crowe 1979a).

MH-4

Au Gres River (44°02', 83°41'). In 1979, chinook salmon were reported at Au Gres (44°03', 83°42') in mid-November (North Woods Call 1979m).

Saginaw River (43°39', 83°51'). Chinook salmon are present in the river in early November (Beak Consult. 1976).

Ontario

The following Canadian streams have spawning runs, usually in September:

OH-1

Srigley Creek (45°43', 82°29'), Mindemoya River (45°40', 82°16'), and Manitou River (45°36', 82°06') (OMNR 1973).

OH-2

Willow Creek (45°10', 81°34') (Environ. Can. 1977c; OMNR 1973).

Spring Creek (45°02', 81°27') (Environ. Can. 1977c).

OH-3

Sauble River (44°40', 81°17') (Environ. Can. 1977c; OMNR 1973).

Saugeen River (44°30', 81°23'). Chinook salmon migrate up the river during September to mid-November (Environ. Can. 1977c; Moccia, pers. comm. 1979; OMNR 1973).

South and North Penetangore Rivers and Kincardine Creek (44°11', 81°39') (Environ. Can. 1977c; OMNR 1973).

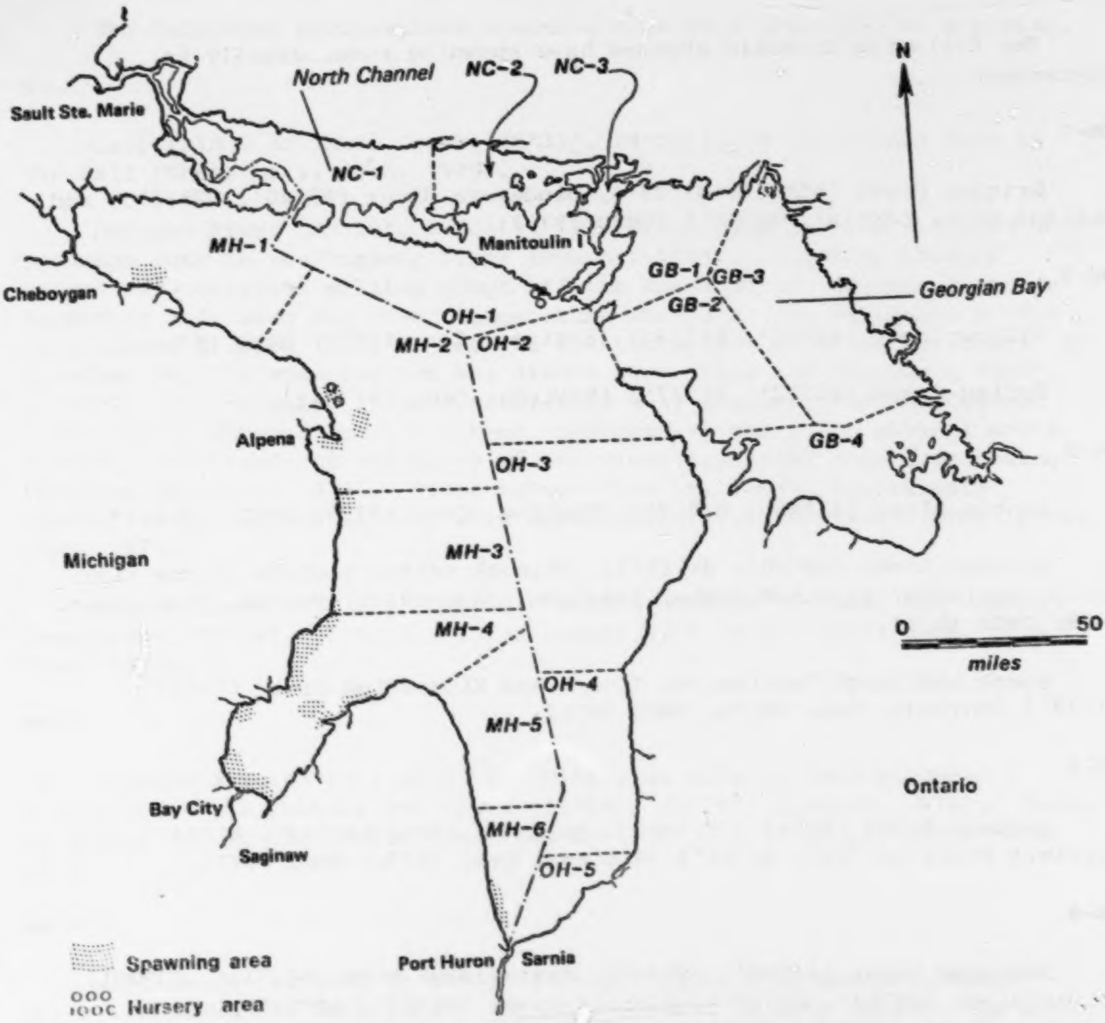
OH-4

Lucknow River (43°53', 81°43'), Maitland River (43°45', 81°44'), and Bayfield River (43°34', 81°43') (Environ. Can. 1977c; OMNR 1973).

GB-4

Sturgeon River (44°44', 79°44'), Nottawasaga River (44°33', 80°00'), Beaver River (44°34', 80°27'), Bighead River (44°37', 80°35'), and Sydenham River (44°35', 80°56') (Environ. Can. 1977c; OMNR 1973).

ROUND WHITEFISH



North Channel
NC-1
NC-2
NC-3
N
Sault Ste. Marie
Manitoulin I
MH-1
Cheboygan
GB-1
GB-2
GB-3
Georgian Bay
OH-1
MH-2
OH-2
Alpena
GB-4
OH-3
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Ontario
Bay City
MH-6
Saginaw
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

In Lake Huron, round whitefish spawn in November and early December (Berst and Spangler 1970a; Koelz 1929). The run to inshore areas begins in mid-October and is heaviest during the last 2 weeks of November (Koelz 1929). Spawning occurs over honeycombed rock and gravel in 24-48 ft of water (Koelz 1929). Round whitefish populations in Lake Huron are stable but rare (Todd 1978).

Michigan

MH-1

Cheboygan (45°39', 84°28'). Fish began moving inshore to honeycombed rock and gravel at depths of 18-30 ft in mid-October, and the run peaked in November (Koelz 1929).

Rogers City (45°25', 83°49'). Many adults enter the city boat harbor in the fall (Hunn, pers. comm. 1979).

Calcite Harbor (45°25', 83°46'). Many adults are caught along shore here, suggesting that the harbor may be a spawning area (FWS 1979d).

MH-2

Middle Island (45°11', 83°20'). Adults began an inshore movement to honeycombed rock and gravel at depths of 18-30 ft in mid-October. The run peaked in November (Koelz 1929). At Rockport (45°12', 83°23') in 1978-79, round whitefish prolarvae were present in April; round whitefish postlarvae were more numerous than those of other species in May (Tex. Instrum. 1979b,c).

Potter Point (45°05', 83°18'). Since the 1930s, spawning has occurred about 8 mi offshore at depths of 20-40 ft (Organ et al. 1978).

Thunder Bay (45°00', 83°20'). Spawning occurs in a rocky area close to shore along the south side of North Point (45°01', 83°16') (O'Gorman, pers. comm. 1979). In 1917, males with pearl organs were taken at Alpena (45°04', 83°26') during the first half of November (Koelz 1929).

MH-3

Black River (44°49', 83°18'). During the 1970s, spawning occurred about 5 mi S of the mouth of the river on gravel substrate at the 10 ft contour in late October and early November (Organ et al. 1978).

MH-4

Saginaw Bay (44°00', 83°30'). Since 1927, round whitefish have spawned from Oscoda (44°25', 83°20') to Point Lookout (44°03', 83°35'), including Tawas Bay (44°16', 83°30'), over rock and gravel out to a depth of about 30 ft and around Charity Island (44°02', 83°26') and Little Charity Island (44°00', 83°28') over rock and gravel out to a depth of 10-12 ft. Spawning also occurred in Wigwam Bay (43°59', 83°50') out to a depth of about 6 ft, in the southern end of the bay from Gilman's Landing (43°48', 83°55') to the mouth of the Quanicasse River (43°35', 83°41'); since 1938 in a small area on the northwest edge of North Island (43°53', 83°25') at depths of 12-14 ft; since 1938 in a small area (43°56', 83°24') north of the tip of Sand Point (43°55', 83°24'), and since 1927 from Oak Point (43°58', 83°16') east to a point (44°00', 83°05') just past Hat Point (44°00', 83°07') (Organ et al. 1978).

MH-6

Port Huron (43°00', 82°26'). In 1913, adults moved inshore to depths of 24 ft 10-12 mi N of Port Huron on November 1. On November 9, large numbers were caught at depths of 42-48 ft; abundance remained high until the fish gradually moved northward again in late November (Koelz 1929).

Ontario

OH-1

Michael Bay (45°35', 82°06'). Young round whitefish were found here in mid-July in about 13 ft of water over a sand bottom with no emergent vegetation (Reckahn 1970).

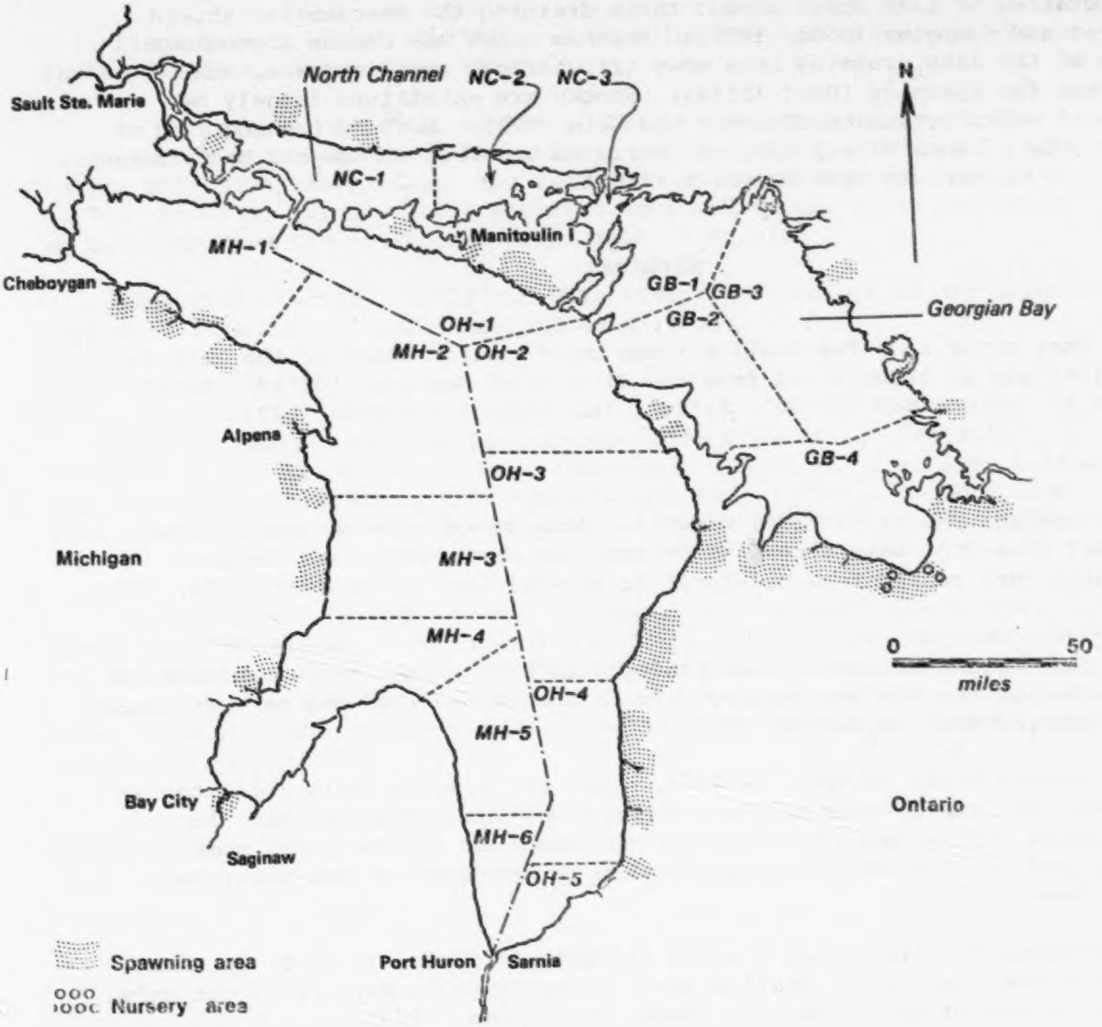
NC-2

Gore Bay (45°56', 82°28') and Kagawong (45°54', 82°15'). In 1917, males with pearl organs were present here during the first half of November (Koelz 1929).

GB-4

Wiarton (44°45', 81°09'). In 1917, males with pearl organs were taken during the first half of November (Koelz 1929).

RAINBOW TROUT


North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
Manitoulin I
MH-1
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
OH-3
GB-4
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Bay City
Ontario
MH-6
Saginaw
OH-5
Spawning area
Nursery area
Port Huron
Sarnia

Rainbow trout were first introduced to the Great Lakes in 1876 when the U.S. Fish Commission stocked the Au Sable River (44°24', 83°19') in Michigan. The first capture of rainbow trout in Lake Huron was recorded near the Les Cheneaux Islands (45°58', 84°20') in 1896. Presumably, rainbow trout entered the Great Lakes from stream plantings because no stocking occurred in the Great Lakes proper (Smedley 1938). Between 1909 and 1913, major spawning runs became established in the Au Sable and Pine (44°30', 83°23') rivers of Michigan (MacCrimmon and Gots 1972).

By 1930, rainbow trout (steelhead trout) reportedly spawned in most tributaries of Lake Huron except those draining the Precambrian shield (Berst and Spangler 1970a, 1973). Rainbow trout are common throughout most of the lake, running into most tributaries, small streams, and ditches for spawning (USDI 1969a). Stocks are maintained largely by natural reproduction (MacCrimmon and Gots 1972). Both spring and fall runs occur; spawning may occur as early as December (Dodge and MacCrimmon 1970) or as late as June (Dunford 1978b).

Michigan

Runs occur in a few small streams on the north shore of the lake in Michigan and in tributaries from the Straits of Mackinac (45°49', 84°45') south to Saginaw Bay (44°00', 83°30') (MacCrimmon and Gots 1972).

MH-1

Cheboygan River (45°39', 84°28'). This river receives one of the largest runs from Lake Huron (MacCrimmon and Gots 1972). In 1979, spawning runs peaked from mid-April to mid-May (Ann Arbor News 1979a; UPI 1979).

Carp (Black Mallard) Creek (45°32', 84°07'). Lake run spawners were collected at the FWS sea lamprey weir in April-June 1947 and in April and May 1948 and 1949 (Applegate 1950).

Ocqueoc River (45°29', 84°04'). Lake-run spawners were collected at the FWS sea lamprey weir on the Ocqueoc River in April-June 1949 (Applegate 1950). Both fall and spring runs occur (Hunn, pers. comm. 1979), and in 1979 the spring run peaked in mid-April to mid-May (Ann Arbor News 1979a).

Hammond Bay Biological Station (45°30', 84°02'). In 1978, spawning activity was observed in shallow water along shore in May; it is not known if this spawning was successful (Hunn, pers. comm. 1979).

Trout River (45°26', 83°50'). A run occurs here in the spring (Hunn, pers. comm. 1979).

MH-2

Thunder Bay River (45°04', 83°26'). This river receives one of the largest runs from Lake Huron (MacCrimmon and Gots 1972). In 1979, the run peaked in mid-April to mid-May (Ann Arbor News 1979a; UPI 1979).

Devils River (44°55', 83°25'). Runs occur here every spring and fall (Stedman, pers. comm. 1979).

MH-3

Black River (44°49', 83°18'). A spawning run occurs here in the spring (Stedman, pers. comm. 1979).

Au Sable River (44°24', 83°19'). This river receives one of the largest runs from Lake Huron (MacCrimmon and Gots 1972; North Woods Call 1979f; UPI 1979); both spring and fall runs occur (Hansen and Stauffer 1967). In 1979, rainbow trout migrated upstream to the Foote Dam about 17 mi upstream from the mouth (Ann Arbor News 1979a,b).

Pine River (44°30', 83°23'). This river receives one of the largest runs from Lake Huron (MacCrimmon and Gots 1972).

MH-4

Whitney Drain (diverted East Branch of Au Gres River) (44°09', 83°34'). A spring run occurs here (Westerman 1957), and fish also entered the stream in mid-November 1979 (North Woods Call 1979m). Rainbow trout also spawned along the lakeshore between Whitestone Point (44°06', 83°34') and the mouth of the stream (Organ et al. 1978).

Au Gres River (44°02', 83°41'). Spawning runs enter the Au Gres River (Ann Arbor News 1979b, Westerman 1952b). This river receives one of the largest runs from Lake Huron (MacCrimmon and Gots 1972a). In 1979, runs peaked from mid-April to mid-May (Ann Arbor News 1979a). Steelhead trout have also been reported at Au Gres (44°03', 83°42') in mid-November (Ann Arbor News 1979m).

Saginaw River (43°39', 83°51'). Small runs are reported in November-May. Peak runs in the Cass River, a tributary, occur in November-December and in March-April (Beak Consult. 1976).

Ontario

Runs of rainbow trout occur in almost every stream along the east shore of the main basin and the south shore of Georgian Bay (45°30', 81°00'). They are absent from most North Channel (46°00', 83°00') tributaries and in tributaries to the southeast that drain the Precambrian shield (MacCrimmon and Gots 1972).

OH-1

Manitoulin Island (45°50', 82°30'). Significant runs are reported in streams on both the north and south sides of the island (MacCrimmon and Gots 1972).

> Mindemoya River (45°40', 82°16') and Srigley Creek (45°43', 82°29'). Spawning runs enter these streams in the spring (OMNR 1973).

Bluejay Creek (45°35', 82°05'). Fall and spring runs enter this stream (OMNR, undated); in 1968, the spring run occurred in late April-late May (Zimmerman 1968).

Manitou River (45°36', 82°06'). Spring and fall runs enter this river (OMNR 1973, undated); in 1968, the spring run occurred in late April-late May (Zimmerman 1968).

OH-2

Willow Creek (45°10', 81°34') and Spring Creek (45°02', 81°27'). Spring runs enter these streams (Environ. Can. 1977c; OMNR 1973).

OH-3

Sauble River (44°40', 81°17'). The spawning run peaks in May (Environ. Can. 1977c; OMNR 1973, undated).

Stony Creek (44°33', 81°20'). Spring runs enter this stream (Environ. Can. 1977c; OMNR 1973).

Saugeen River (44°30', 81°23'). A fall run enters the river in August-December; a spring run occurs in April-June and peaks in May (Environ. Can. 1977c; Moccia, pers. comm. 1979; OMNR 1973, 1975a, undated).

Bruce Generating Station (44°19', 81°36'). In 1977, redd building was observed in the discharge canal in late May and early June and viable eggs were recovered. Ripe adults were found in Baie du Dore (44°20', 81°33') in October (Dunford 1978b).

North and South Penetangore Rivers and Kincardine Creek (44°11', 81°39') and Little Sauble River (44°17', 81°36'). Spring spawning runs enter these streams (Environ. Can. 1977c; OMNR 1973).

OH-4

Eighteen Mile River (44°01', 81°44'). Spring spawning runs enter this river (Environ. Can. 1977c; OMNR 1973).

Lucknow River (43°53', 81°43'). Fall and spring runs enter this river (Environ. Can. 1977c; OMNR 1973, undated).

Maitland River (43°45', 81°44'). Fall and spring runs enter this river; the spring run peaks in May (Environ. Can. 1977c; OMNR 1973, undated). The first spring run was recorded in 1921 (MacCrimmon and Gots 1972).

Bayfield River (43°34', 81°43'). Spring spawning runs enter this river (Environ. Can. 1977c; OMNR 1973); the first recorded run was in 1935 (MacCrimmon and Gots 1972).

OH-5

Ausable River (43°19', 81°46'). Spring spawning runs enter this river (Environ. Can. 1977c; OMNR 1973).

NC-1

Jaggers Creek (46°15', 83°53'), Thessalon River (46°15', 83°34'), and Mississagi River (46°10', 83°01'). Minor runs occur in these streams (OMNR 1976b).

Silver Creek (45°55', 82°50'). Spawning runs enter this stream in the spring (OMNR 1973).

GB-3

Naiscoot River (45°40', 80°34'). Spawning runs enter this river in the spring (OMNR 1973).

Moon River (45°08', 79°59'). Spawning runs enter this river in the spring (Environ. Can. 1977c; OMNR 1973).

GB-4

Coldwater River (44°44', 79°39'). Spawning runs enter this river in the spring (Environ. Can. 1977c; OMNR 1973).

Sturgeon River (44°44', 79°44'). A large spring run enters the Sturgeon River (Environ. Can. 1977c; OMNR 1973; Thede 1970). Many gravel areas excellent for spawning occur in the river. A concrete bridge support about 1 mi upstream from the mouth blocks the migration, and most of the fish spawn in the 1/2 mi stretch of river immediately below the bridge. In 1970, spawning occurred from early April to early May when the water temperature was about 37°F (Thede 1970).

Hog Creek (44°45', 79°47') and Copeland Creek (44°46', 79°57'). Spawning runs enter these streams in the spring (Environ. Can. 1977c; OMNR 1973).

Nottawasaga River (44°33', 80°00). This river is used extensively for spawning and as a nursery ground (Berst and Wainio 1967). Spawning takes place in April and May, adults return to Lake Huron after spawning, and the young remain in the stream for 1-3 years before migrating to the lake (Wainio 1962). Runs have occurred recently in the fall and spring, and the spring runs peak in April (Environ. Can. 1977c; OMNR 1973, undated).

Batteaux River (44°29', 80°10'). Spring runs enter this river (Environ. Can. 1977c; OMNR 1973).

Pretty River (44°30', 80°12'). Runs enter this river (Environ. Can. 1977c; OMNR 1973) in the fall and spring, and the spring run peaks in May (OMNR, undated).

Silver Creek (44°31', 80°17'). Spawning runs enter this stream (Environ. Can. 1977c; OMNR 1973) in April, May, or June, and peak spawning occurs in April to mid-May (Lamsa 1963b). In 1958, the spawning run began in early April and peaked at the end of April (Lamsa 1961); the last spawning-run fish were collected on June 27. In 1959, the start of the run coincided with the rise in the weekly mean water temperature from 34°F to 41°F; the first fish was taken on April 10, and the last on May 29. Spent fish migrated to Lake Huron in May, but some remained in the stream throughout the summer. Parr remained in the stream until they reached 1 or 2 years of age and then migrated to Lake Huron; most migration occurred in May and June, but some occurred as early as March and as late as August. A small fall run of mainly 2 and 3 year old adults was observed in late October to mid-November (Lamsa 1963b).

Indian Brook (44°33', 80°26'), Beaver River (44°34', 80°27'), and East Meaford Creek (44°36', 80°33'). Spring runs enter these streams (Environ. Can. 1977c; OMNR 1973).

Bighead River (44°36', 80°35'). Fall and spring runs enter this river; the spring run peaks in May (Environ. Can. 1977c; OMNR 1973, undated).

Johnston Creek (44°43', 80°46'), Waterton Creek (44°42', 80°48'), and Keefer Creek (44°38', 80°52'). Spring runs enter these streams (Environ. Can. 1977c; OMNR 1973).

Telfer (Bothwell's) Creek (44°38', 80°52'). Runs consistently proceed to the headwaters (MacCrimmon and Gots 1972). The creek generally has two runs, which occur earlier than in neighboring streams (Dodge 1972; Environ. Can. 1977c; OMNR 1973). In 1965-66, the first run occurred October 29-February 15; spawning occurred December 29-February 14, and peaked January 15-February 5. The second run occurred February 16-May 3; spawning occurred February 20-April 30, and peaked March 16-April 16. Fish from the first run returned to the lake before the second run entered the creek (Dodge and MacCrimmon 1970). During 1966-70, fish were seen in the headwaters and spring-fed tributaries of the creek as early as mid-December (Dodge 1972). Spawning was observed and viable eggs were found in redds as early as December 27, and as late as April 26, when water temperatures were about 32.5 and 50°F, respectively (Dodge 1972; Dodge and MacCrimmon 1971). Peak spawning occurred in March-early April at about 43-46°F (Dodge and MacCrimmon 1971).

Sydenham River (44°35', 80°56'). Major runs occur from November to April (Dodge 1972; Environ. Can. 1977c; OMNR 1973), particularly in mid-November to mid-December, late January to early March, and late March to early April. Pre-spawners remain below a fishway about 0.3 mi from the mouth. A few fish spawn in the rapids below the fishway, but most climb the fishway and spawn between the reservoir and the falls about 3 mi from the mouth. In 1966-70, first spawning occurred April 8-17 at about 37-41°F. The lowest temperature at which spawning was observed was about 37°F. Peak spawning occurs in April and May at about 37-44°F (Dodge 1972).

Pottawatomi River (44°35', 80°56'). Runs occur from November to April (Dodge 1972; Environ. Can. 1977c; OMNR 1973), particularly in mid-November to mid-December, late January to early March, and late March to early April. The early migrants remain in deep, ice-covered pools near the mouth until spring. In 1966-70, the first spawning occurred in mid-February to mid-March at about 36-39°F. The lowest temperature at which spawning was observed was about 34°F. Peak spawning occurs in April-May at 37-45°F. Runs are blocked by falls about 2.7 mi from the mouth (Dodge 1972).

Indian Creek (44°37', 80°57'). Spring runs enter this stream (Environ. Can. 1977c; OMNR 1973).

ATLANTIC SALMON

Atlantic salmon were first introduced into the U.S. waters of Lake Huron in 1873. No self-sustaining populations were established from this and subsequent plantings (Parsons 1973). Plantings of Atlantic salmon were made in the Au Sable River (44°24', 83°19') in 1972 and 1973 (GLFC 1973b, 1975, 1976a, 1978; Rybicki 1973), but no spawning runs developed.

BROWN TROUT

Brown trout were introduced into the Great Lakes in the 1880s. No information was found concerning the introduction of brown trout into Lake Huron; presumably brown trout entered the lake from streams that had been stocked (Moffett 1958).

Michigan

MH-1

Carp River (46°02', 84°41'). A fishery was expected to develop in 1980 near the river mouth during late August-early September (North Woods Call 1980a); this suggests that a spawning run may occur here.

MH-2

Thunder Bay (45°00', 83°20'). A commercial fisherman reported spawning in the northwest part of Whitefish Bay (Organ et al. 1978).

MH-4

Whitestone Point (44°06', 83°34'). A commercial fisherman reported spawning along shore in a small area (44°07', 83°34') north of the point (Organ et al. 1978).

Saginaw River (43°39', 83°51'). A few sexually mature fish were taken near the river mouth in late September (Beak Consult. 1976).

Ontario

Brown trout from Lake Huron enter the following streams in October and November to spawn (Environ. Can. 1977c; OMNR 1973, 1975a):

OH-2

Willow Creek (45°10', 81°34').

OH-3

Saugeen River (44°30', 81°23').

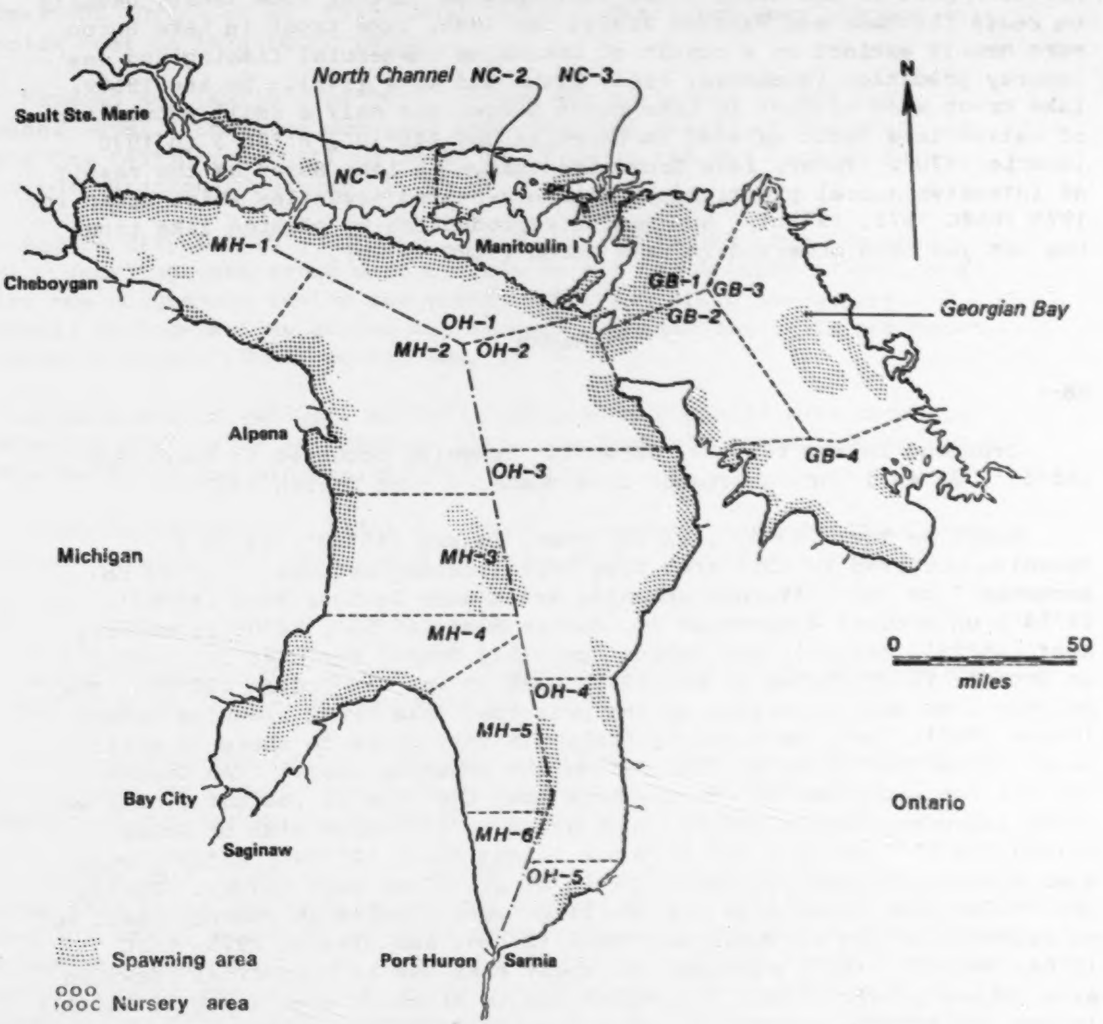
OH-4

Bayfield River (43°34', 81°43').

GB-4

Coldwater River (44°44', 79°39'), Nottawasaga River (44°33', 80°00'), Telfer Creek (44°38', 80°52'), Sydenham River (44°35', 80°56'), and Pottawatomi River (44°35', 80°56').

LAKE TROUT


North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
MH-1
Manitoulin I
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
GB-4
OH-3
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Bay City
Ontario
Saginaw
MH-6
OH-5
Spawning area
Nursery area
Port Huron
Sarnia

Historically, lake trout were abundant in Lake Huron. Lake trout spawned over reefs of honeycombed rock 10-15 mi from shore at depths ranging from 6-120 ft (Dymond 1928; Goode 1884; Leach 1923; U.S. Comm. Fish Fish. 1900). Spawning also occurred along the shoreline at all suitable locations adjacent to areas inhabited by lake trout (Rathbun and Wakeham 1897). Spawning occurred in the lake during October 15-December 1 (Kerr and Kerr 1860-1898; Lagler 1948; Leach 1923; MacKay 1969; Smith 1968; Rathbun and Wakeham 1897; U.S. Comm. Fish Fish. 1900). The various races of trout spawned at different times (Koelz 1926). "Shallow-water" trout began spawning as early as September in water 2-8 ft deep (MSBFC 1890; Rathbun and Wakeham 1897; U.S. Comm. Fish Fish. 1900). Other trout spawned between mid-October and late November, or even later in the northern part of the lake; these fish spawned further from shore, usually on reefs (Rathbun and Wakeham 1897). By 1959, lake trout in Lake Huron were nearly extinct as a result of intensive commercial fishing and sea lamprey predation (Eschmeyer 1964; Pycha and King 1975). By the 1960s, lake trout were extinct in Lake Huron proper and only a small population of native lake trout existed in Georgian Bay (45°30', 81°00') in 1970 (Lawrie 1970). Today, lake trout are common in Lake Huron as the result of intensive annual plantings of hatchery-reared juveniles which began in 1973 (GLFC 1975, 1979b). Successful reproduction by planted lake trout has not yet been observed in Lake Huron (GLFC 1979b).

Michigan

MH-1

Drummond Island (46°00', 83°40'). Spawning occurred in Huron Bay (45°57', 83°46') during October 23-November 1 (Van Oosten 1927a).

Point De Tour (45°57', 83°55')--St. Ignace (45°52', 84°43'). Spawning occurred in this area from approximately October 15 or 20 to November 1 or 10. Offshore spawning areas were De Tour Reef (45°57', 83°54') on October 4-November 10, Martin Reef (45°55', 84°09'), Pomeroy Reef (45°55', 84°12'), and Tobius (possibly Tobin) Reef (45°56', 84°12') on October 14-25 (Organ et al. 1978; Peck 1979a; Van Oosten 1927a). The De Tour area was identified as the principal lake trout spawning ground (Goode 1884). Nets were set by fishermen very close to shore in shallow water at De Tour to catch fish during the spawning season (Van Oosten 1927a); the water was so shallow here that the tips of the net floats were above the water (Goode 1884). Rock areas on the south side of Goose Island (45°55', 84°25') and on Goose Island Shoal (45°54', 84°29') were also historical spawning areas (Organ et al. 1978; Peck 1979a). During the 1970s, lake trout eggs and yearlings were planted on Pomeroy Reef, but no evidence of egg survival was found (Behmer and Gleason 1975; GLFC 1976a; Wagner 1978b), although the rocky reef was an historical spawning area (Organ et al. 1978). A dredged spoils disposal area south of LaSalle Island (at 45°57', 84°19') was also identified as a spawning ground, but dates of use are not known (Organ et al. 1978).

Mackinac Island (45°52', 84°38')--Bois Blanc Island (45°46', 84°27'). The rocky Graham Shoals (45°50', 84°42') and Majors Shoal (45°49', 84°40') off St. Ignace (45°52', 84°43') are historical spawning areas (Organ et al. 1978; Peck 1979a); yearling lake trout were planted on the Graham Shoals in 1974 (GLFC 1976). Other historical spawning areas included Round Island (45°50', 84°36'), the rock area between Round Island and Mackinac Island, and Lime Kiln Point (45°49', 84°35'), Lighthouse Point (45°49', 84°25'), Lafayette Point (45°46', 84°21'), Poe Reef (45°42', 84°22'), and Zela Shoal (45°46', 84°33') at Bois Blanc Island (Organ et al. 1978; Peck 1979a). Yearlings were planted on Zela Shoal in 1974 (GLFC 1976a). The honeycombed rock of Spectacle Reef (45°46', 84°08'), Raynolds Reef (45°47', 84°13'), and the 36 ft deep bank (45°45', 84°16') southwest of Raynolds Reef were spawning areas for "native" trout during the 1930s-1940s (Organ et al. 1978; Peck 1979a). Yearlings were planted on Raynolds Reef in 1974 (GLFC 1976a).

Hammond Bay (45°30', 84°05'). Spawn was collected in the bay (Ravenel 1898). Spawning occurred over rock and gravel at the south end of the bay (45°30', 84°03') in 10-20 ft of water off the Hammond Bay Biological Station (Organ et al. 1978).

Rogers City (45°25', 83°49'). Spawn was collected here (Ravenel 1898). Yearling lake trout were stocked here in 1974 (GLFC 1976a), and adults now congregate inside the yacht harbor and along the quarry breakwall at Rogers City during the spawning season, but it is not known if spawning occurs (Hunn, pers. comm. 1979).

Calcite Harbor (45°25', 83°46'). Many mature adults were recently reported in the harbor in October; they were probably attempting to spawn on the shoreline and breakwalls (FWS 1979d).

Adams Point (45°25', 83°43'). Spawning occurred just north of the point on gravel bottom at a depth of about 60 ft (Organ et al. 1978).

MH-2

Adams Point (45°25', 83°43'). Spawning occurred on the shoal along the east side of the point (Organ et al. 1978).

Thompsons Harbor (45°21', 83°36'). Native lake trout spawned at the 6-30 ft depth contours in the harbor and also on honeycombed rock northwest of the harbor at depths of about 40-50 ft (Organ et al. 1978).

Presque Isle Light (45°21', 83°30'). Spawning occurred in the Presque Isle Light District on October 20-November 5 (Van Oosten 1927a). During the 1930s, spawning occurred near Presque Isle Light on honeycombed rock bottom on the east side of North Bay (45°21', 83°30') and in an area about 3 mi NE of the Light (at 45°23', 83°27') at a depth of about 180 ft; "siscowets" or "fat" trout spawned about 12 mi NE of Presque Isle Harbor, (at 45°30', 83°21') at a depth of 300 ft (Organ et al. 1978). Old Presque Isle Lighthouse Reef (45°20', 83°28') is also an historical spawning ground (Peck 1979a).

False Presque Isle (45°16', 83°23'). In the 1930s-1970s, the gravel and honeycombed rock shoal (45°15', 83°22') off the southeast side was used for spawning (Organ et al. 1978). [Authors' note: We believe the statement that lake trout spawned in "...1930s-1970s..." is misleading or incorrect. Although a small population of native lake trout persisted in Georgian Bay at least until 1970 (Lawrie 1970), native lake trout were extinct in Lake Huron proper by the 1960s (Eschmeyer 1964; Pycha and King 1975). Hatchery reared juveniles were not planted in Lake Huron until 1973 (GLFC 1975, 1979b) and these fish probably would not have reached sexual maturity until the late 1970s. Strays from plantings begun in Lake Michigan in 1965 could have spawned in Lake Huron, but probably not before 1970.]

Middle Island (45°11', 83°20'). Spawning occurred here on September 20-October 15 (Van Oosten 1927a). As early as the late 1800s, the rocky, gravel shoals near the island were favorite spawning sites for "shoal-water" trout; spawning began here in late September (Smith and Snell 1891). Middle Island Reef (45°11', 83°18') is an historical spawning ground (Peck 1979a). Commercial fishermen reported that spawning occurred around the east and south sides of the island from the 1920s-1960s (Organ et al. 1978). The Rockport-Stoneport Reef (45°14', 83°23') is an historical spawning ground (Peck 1979a). In 1978-79, many adults were found at Rockport (45°12', 83°23') in October, and most were running-ripe or spent. The rock, boulder, and rubble substrate here is suitable for spawning, but no eggs or young were found in 1979 (Tex. Instrum. 1979b,c).

South Nine Mile Point (45°08', 83°19')--Potter Point (45°05', 83°18'). Commercial fishermen reported that lake trout spawned during the 1970s over a gravel shoal (45°07', 83°13') at depths of 24-30 ft in an area 3-8 mi offshore between these points (Organ et al. 1978).

Thunder Bay Island (45°03', 83°12')--North Point (45°01', 83°16'). Spawning occurred in this area and around the nearby reefs beginning about October 1 (Van Oosten 1927a). The rocky shallows near Thunder Bay Island were a favorite spawning area for the shoal-water trout, as early as the late 1800s. Spawning began here in late September (Clark 1886; Smith and Snell 1891). From the 1920s-1960s, spawning occurred in an area that extends westward from the south shore of Sugar Island (45°03', 83°14'). North Point Reef (45°00', 83°15') is an historical spawning ground, which was used during the 1970s (Organ et al. 1978; Peck 1979a).

Thunder Bay (45°00', 83°20'). In 1977 and 1979, ripe lake trout were found in late September to October off the Huron Cement Company (45°04', 83°24') in about 15-18 ft of water, but spawning was not documented there (Stedman, pers. comm. 1979). Ripe lake trout spawned in the bay from late October to mid-November (Van Oosten 1927a). Spawn was collected in October and November near Alpena (45°04', 83°26') (Ravenel 1898). Smaller "shoal" trout, which spawned in September-October, were also found in the area (Clark 1886; U.S. Comm. Fish Fish. 1900). During the 1970s, spawning occurred on a small gravel area northeast of Scarecrow Island (44°55' 83°20') (Organ et al. 1978).

South Point (44°53', 83°19')--Black River (44°49', 83°18'). Since the 1920s, lake trout have spawned in this area along shore over gravel, rock, and mud (Organ et al. 1978). Black River Island Reef (44°50', 83°17') is an historical ground (Peck 1979a). Spawning occurred until the 1960s throughout the region and until the 1970s on a gravel area that extended about 2 mi N of Black River Island (Organ et al. 1978). In 1974, yearlings were planted in the area north of Black River Island (GLFC 1976a).

MH-3

Black River (44°49', 83°18')--Cedar Lake (44°32', 83°20'). During the 1920s-1960s, lake trout spawned along shore over gravel, rock, clay, and mud (Organ et al. 1978). Sturgeon Point Reef (44°43', 83°15') is an historical ground (Peck 1979a); spawning occurred here from approximately mid-October to early November (Van Oosten 1927a).

Big Reef (Six Fathom Bank) (44°49', 82°30'). This reef, and especially the portion of it about 40 mi out from Alpena (45°04', 83°26'), was the most important historical spawning ground in the lake (Peck 1979a; Rathbun and Wakeham 1897; Smith and Snell 1891). Trout began congregating at the edges of the reef in the summer and moved onto the shallowest portions to spawn (Rathbun and Wakeham 1897); some fish spawned from approximately late October to late November (Smith and Snell 1891), and "black" trout spawned on the reef as late as December (Koelz 1926).

Yankee Reef (44°28', 82°35'). Spawning historically occurred here from mid-October to November 1 (Peck 1979a; Van Oosten 1927a).

MH-4

Tawas Point (44°15', 83°27')--Point Lookout (44°03', 83°35'). During the 1930s-1940s, lake trout spawned along the shoreline over rock and gravel (Organ et al. 1978). Spawning occurred in Tawas Bay (44°16', 83°30') in mid- to late October and at Tawas Point during October 1-20 (Van Oosten 1927a). Running ripe adults are abundant at Alabaster (44°11', 83°33') in October; no evidence of spawning has been found, although the rock bottom provides suitable substrate (Tex. Instrum. 1979b,d).

Point Au Gres (43°59', 83°41')--Wigwam Bay (43°59', 83°50'). Spawning occurred between these points out to a depth of about 24 ft over rock and mud. The substrate is rock, mud, and vegetation just west of the Au Gres Boat Club (44°00', 83°43'), where spawning occurred during the 1940s. In 1978, planted trout spawned over sand in a nearshore area between the mouth of the Rifle River (44°00', 83°45') and Wigwam Bay (Organ et al. 1978).

Charity Islands (44°01', 83°27'). Spawning occurred here during October (Van Oosten 1927a). Since 1915, lake trout spawned on the rock, gravel, and sand shoals around Charity Island (44°02', 83°26') and Little Charity Island (44°00', 83°28'); spawning also occurred there in 1978 (Organ et al. 1978).

Coreyon Reef (44°00', 83°28'--43°40', 83°50'). During 1928-64, lake trout spawned over the gravel and sand reef running southwest from the Charity Islands (44°01', 83°27') (Organ et al. 1978).

Sand Point (43°55', 83°24')--Oak Point (43°58', 83°16'). During the 1930s-1940s, spawning occurred along shore over sand and rock. From 1917 through the 1960s, spawning also occurred on the 4-6 ft deep shoal areas extending from 1-1/2 to 5 mi NW of Sand Point (Organ et al. 1978).

Oak Point (43°58', 83°16')--Hat Point (44°00', 83°07'). During the 1930s-1940s, spawning occurred from Oak Point to an area about 2 mi E of Hat Point (44°00', 83°05') over rock, sand, and gravel to a depth of about 24 ft (Organ et al. 1978).

Port Austin (44°03', 83°00')--Grindstone City (44°03', 82°54'). Spawning occurred in this area from approximately mid-October to November 1 (Van Oosten 1927a). The Port Austin Reef (44°04', 82°59') is an historical spawning ground (Peck 1979a). In 1974, yearling lake trout were planted at Grindstone City (GLFC 1976a). Spawning was recently reported over rock and gravel just off Grindstone City (Organ et al. 1978).

MH-5, MH-6

Harbor Beach (43°51', 82°39')--Port Sanilac (43°26', 82°32'). During the 1930s-1940s, lake trout spawned along the international border between Harbor Beach and Port Sanilac over a mid-lake, honeycombed rock area at depths of approximately 150-250 ft (Organ et al. 1978).

Ontario

Lake trout in Canadian waters spawned on October 15-December 1 (MacKay 1956b). The following information for Canadian waters is from Smith (1968), unless otherwise specified; the characterization of spawning grounds as "major" or "minor" follows Smith (1968):

OH-1

Cockburn Island (45°55', 83°20'). Lake trout moved onshore here to spawn in early October (Ont. Game Fish 1913a). Spawning occurred at Castilian Rock (45°52', 83°17') over 480 acres of honeycombed rock at depths of 12-72 ft and along the south shore of the island from Ricker (possibly Rickett) Harbour (45°53', 83°17') to Wheeler Rock (possibly Reef) (45°54', 83°31') over 20,480 acres of honeycombed rock at depths of 12-96 ft.

Manitoulin Island (45°50', 82°30'). The south side of the island was one of the most important spawning grounds on the Canadian shore (Rathbun and Wakeham 1897). Major grounds were the shoals, reefs, and banks all along the south shore; spawning occurred from about October 25 to November 15 in areas along the southeast shore of the island (45°41', 82°20'--45°31', 81°50') and November 1-15 in the areas along the southwest shore of the island (45°52', 83°15'--45°41', 82°20'). Spawners were last taken in 1939 in the South Bay area and in 1940 farther west.

> Carter Rock (45°51', 83°12'). Spawning occurred over 160 acres of honeycombed rock at depths of 12-66 ft, and over 720 acres of honeycombed rock along the shoreline from the rock to Near Light (45°52', 83°13') at depths of 15-60 ft.

Greene Island (45°49', 83°07'). Spawning occurred over 2,240 acres of honeycombed rock along the south shore and on a bank south and west of the island at depths of 18-66 ft.

Jones Shoal (45°49', 83°04'). Spawning occurred over 640 acres of honeycombed rock at depths of 24-54 ft.

Belonger Bay (45°49', 83°02'). Spawning occurred over 360 acres of honeycombed rock at depths of 18-42 ft.

Stafford Rock (45°48', 82°59'). Spawning occurred over 240 acres of honeycombed rock on the shoal west of the rock at depths of 18-54 ft.

Duck Islands (45°43', 82°56'). Spawning occurred over 560 acres of honeycombed rock on the shoal south of Inner Duck Island (45°45', 82°55') at depths of 12-48 ft; over round stones on the shoals south of Great and Outer Duck Islands (45°37', 82°56') at depths of 12-72 ft; and over 360 acres of honeycombed rock at Western Duck Reef (45°47', 83°02') at depths of 24-42 ft.

Thibault Shoal (45°47', 82°55'). Spawning occurred over 320 acres of gravel at depths of 12-60 ft. Lake trout formerly spawned at depths of about 3-6 ft in Burnt Island Bay (Berst and Spangler 1970b).

Walkhouse Point (45°47', 82°52'). Spawning occurred over 1,200 acres of honeycombed rock on shoals off the point at depths of 12-60 ft.

Hensley Bay (45°46', 82°48'). Spawning occurred over 600 acres of honeycombed rock on a shoal south of the bay at depths of 18-60 ft.

Frenchette Bank (45°45', 82°42'). Spawning occurred over 480 acres of honeycombed rock at depths of 18-48 ft.

Shamrock Bank (45°44', 82°36'). Spawning occurred over 1,400 acres of honeycombed rock south of the bank at depths of 30-72 ft.

Murphy Harbour (45°47', 82°40')--Portage Bay (45°45', 82°32'). Spawning occurred over 2,880 acres of flat, broken, and honeycombed rock along the shoreline at depths of 12-60 ft. Spawning occurred over 720 acres of honeycombed rock on a bank 2 mi S of Murphy Harbour (at 45°44', 82°40') at depths of 54-66 ft.

Thistle Reef (45°44', 82°32'). Spawning occurred over 1,120 acres of gravel and broken rock at depths of 12-42 ft.

Melville Point (45°43', 82°29'). Spawning occurred over 200 acres of honeycombed rock at depths of 12-42 ft.

Dominion Point (45°40', 82°28'). Spawning occurred over 360 acres of honeycombed rock, 2 mi SW of the point at depths of 54-72 ft.

Buckeye Shoal (45°36', 82°12'). Spawning occurred over 960 acres of honeycombed rock at depths of 12-60 ft.

Timber Bay Shoal (45°37', 82°14')--Advance Reef (45°34', 82°10'). Spawning occurred over 4,000 acres of honeycombed rock at depths of 36-96 ft.

Advance Reef (45°34', 82°10'). Spawning occurred over 1,280 acres of honeycombed rock at depths of 12-60 ft.

Michael Point (45°35', 82°07')--Walker Point (45°33', 82°05'). Spawning occurred over 1,760 acres of honeycombed rock at depths of 12-54 ft.

Volunteer Spit (45°33', 82°04')--Red Dan Rock (45°33', 82°03'). Spawning occurred over 560 acres of honeycombed rock at depths of 12-60 ft.

South Bay (45°38', 81°52'). A resident population moved to shallow water in the bay's inner basin in October to spawn on broken rock along shore (Fry 1952).

Wallace Rock (45°32', 82°01'). Spawning occurred over 100 acres of honeycombed rock at depths of 18-36 ft.

McGaw Point (45°32', 82°00'). Spawning occurred over 320 acres of honeycombed rock south of the point at depths of 24-54 ft.

Thomas Point (45°32', 81°58'). Spawning occurred over 320 acres of honeycombed rock at depths of 12-60 ft.

Todman Reef (45°32', 81°56')--Vigilant Rock (45°31', 81°55'). Spawning occurred over 960 acres of honeycombed rock at depths of 12-60 ft.

OH-2

Fitzwilliam Island (45°30', 81°45'). Spawning occurred over honeycombed rock west and southwest of the island at depths of 18-84 ft in October. Major grounds were Little Rock (45°29', 81°51') to Emily Maxwell Reef (45°27', 81°50), the area from Indian Harbour Reef (45°26', 81°49') to McLelan Rock (45°25', 81°49') to Smith Rock (45°25', 81°49'), Manitoba Ledge (45°24', 81°49'), and West and East Sister Patches (45°22', 81°48'). The last reported spawning was in 1945.

Cape Hurd (45°13', 81°44'). Major ground; spawning occurred over honeycombed rock on the 720-acre Southwest Bank at 45°15', 81°46', and on the 200-acre Northwest Bank at 45°17', 81°45'. Spawning occurred here in October and was last reported in 1945.

Cape Hurd (45°13', 81°44')--Scotch Thistle Point (45°00', 81°27'). Shoals off the west shore of the Bruce Peninsula were important spawning areas (Ont. Game Fish 1932). Major ground; spawning occurred on 75,000 acres of honeycombed rock along the shoreline at depths of 12-74 ft. Spawning occurred on October 10-November 10 and was last reported in 1942.

OH-3

Scotch Thistle Point (45°00', 81°27')--Main Station Island (44°45', 81°19'). Major ground; spawning occurred at depths of 12-74 ft on October 10-November 10; last reported in 1942.

Chiefs Point (44°42', 81°18'). Major ground; spawning occurred at 44°40', 81°24' on 800 acres of honeycombed rock at depths of 90-108 ft. Minor spawning occurred at 44°40', 81°20' on a honeycombed rock ridge at depths of 36-72 ft. Spawning occurred on October 20-November 1 and was last reported in 1942.

Frenchman Bay (44°35', 81°18'). Major ground; spawning occurred over honeycombed rock ridges (44°35', 81°20') at depths of 42-54 ft on October 20-November 10; last reported spawning was in 1942.

Chantry Island (44°30', 81°24')--MacGregor Point (44°25', 81°29'). Major ground; spawning occurred over honeycombed rock ridges (44°30', 81°30') at depths of 60-120 ft; the last reported spawning was in 1942. Lake trout migrated 60 mi during October from the deep water off Southampton (44°30', 81°22') and behind Big Reef (44°45', 82°32') to smaller reefs along the shore of the Bruce Peninsula (45°00', 81°20') (Kerr and Kerr 1860-1898). In 1908, 30 tons of large females were caught on November 9-10; these fish were assumed to be moving to spawning beds (Ont. Game Fish 1909). The area north of Southampton was one of the spawning grounds for shoal-water trout in late 1890s (Rathbun and Wakeham 1897).

MacGregor Point (44°25', 81°29')--Scott Point (44°21', 81°33'). Major ground; spawning occurred over honeycombed rock ridges (44°24', 81°35') at depths of 48-102 ft on October 20-November 10; the last reported spawning was in 1942.

McPherson Point (44°20', 81°35')--Inverhuron (44°17', 81°35'). Major ground; spawning occurred over honeycombed rock ridges (44°19', 81°38') at depths of 66-102 ft on October 20-November 10; the last reported spawning was in 1942.

Kincardine (44°10', 81°38'). Major ground; spawning occurred 16 mi W-NW of Kincardine over 3,240 acres of honeycombed rock (44°14', 81°59') at depths of 72-108 ft on October 20-November 10; the last reported spawning was in 1942.

OH-4

Point Clark (44°04', 81°45'). The area (44°00', 81°45') south of Point Clark was a major spawning ground. Spawning occurred in crescent-shaped areas of honeycombed ridges at depths of 24-120 ft on October 20-November 10; the last reported spawning was in 1942.

OH-5

Kettle Point (43°13', 82°01'). Spawning occurred on October 20-November 10; the last reported spawning was in 1940.

In Georgian Bay (45°30', 81°00'), spawning occurred in October (Ont. Game Fish 1909, 1910, 1915) all along the shore, around the islands, and on the offshore reefs and shoals; spawning occurred earlier in offshore waters than in nearshore waters (Bensley 1915; Rathbun and Wakeham 1897). Georgian Bay was an important center for spawn collection (Ont. Game Fish 1933; Redband 1915).

In the North Channel (46°00', 83°00'), lake trout generally spawned about 1 week earlier than in Lake Huron proper (Smith 1968). Large amounts of spawn were taken in the North Channel (Ont. Game Fish 1913a).

NC-1

Colby Island (46°18', 83°53')--southeast end of Portlock Island (46°18', 83°53'). Minor ground; spawning occurred here at depths of 24-30 ft on October 20-30; the last reported spawning was in 1950.

Plummer Bank (46°18', 83°54'). Minor ground; spawning occurred over honeycombed rock at depths of 12-30 ft on October 20-30; the last reported spawning was in 1950.

McKay Island (46°17', 83°47'). Minor ground; spawning occurred on the south side of the island over gravel at depths of 30-42 ft on October 20-30; the last reported spawning was in 1950.

St. Joseph Island (46°13', 84°00'). The stomachs of round whitefish taken here contained lake trout eggs (Ont. Game Fish 1913b). Spawning occurred on October 20-30 off the east and south sides of Big Point (46°13', 83°47') over rock and gravel at depths of 30-36 ft, and off the east side of Gravel Point (46°16', 83°50') over limestone at depths of 30-42 ft; the last reported spawning was in 1950.

Fox Island (46°11', 83°46'). Minor ground; spawning occurred over 300 acres of honeycombed rock at depths of 12-24 ft on October 10-20; the last reported spawning was in 1950.

Beef Island (46°09', 83°48'). Spawning occurred on the east side of the island over 60 acres of small, round rock at depths of 24-30 ft on October 20-30; the last reported spawning was in 1950.

O'Donnell Island (46°08', 83°47')--Perrique Island (46°08', 83°46'). Minor ground; spawning occurred between the islands over 490 acres of gravel and honeycombed rock at depths of 12-18 ft on October 20-30; the last reported spawning was in 1950.

Birch Island (46°15', 83°41'). Minor ground; spawning occurred on the east side of the island over 210 acres of rock and mud at depths of 12-30 ft on October 20-30; the last reported spawning was in 1950.

Thessalon Island (46°12', 83°38'). Spawning occurred on the south and southwest sides of the island over 400 acres of rock at depths of 6-12 ft on October 20-30; the last reported spawning was in 1950.

Gull Island (46°10', 83°37'). Minor ground; spawning occurred on the west and south sides of the island over 240 acres of rock at depths of 6-12 ft on October 20-30; the last reported spawning was in 1950.

Sulphur Island (46°09', 83°37'). Minor ground; spawning occurred on the north side of the island over 100 acres of gravel, sand, and possibly limestone on October 20-30; the last reported spawning was in 1950.

Bigsby Island (46°10', 83°26'). Minor ground; spawning occurred over patchy honeycombed rock at depths of 30-36 ft on October 20-30; the last reported spawning was in 1950.

McGlashan Patch (46°09', 83°24'). Minor ground; spawning occurred over rock at depths of 12-30 ft on October 20-30; the last reported spawning was in 1950.

Grant Islands (46°08', 83°18'). Minor ground; spawning occurred on October 20-30 on the east side of East Grant Island (46°08', 83°17') over mud bottom at depths of 12-48 ft, on the southeast side of Middle Grant Island (46°08', 83°19') over broken rock at depths of 12-30 ft, and on the south side of West Grant Island (46°08', 83°21') over 3,123 acres of rock at depths of 12-30 ft. The last reported spawning was in 1950.

John Island (46°08', 82°35')--Cape Robert (46°00', 82°49'). Minor ground; spawning occurred over round stones at depths of 12-60 ft on October 10-30. Specific locations were Capana Shoal (46°06', 82°54'), Cousins Shoal (46°05', 82°49'), Europa Reef (46°05', 82°46'), Maitland Patch (46°05', 82°44'), Black Rock (46°07', 82°50'), Gunboat Shoal (46°08', 82°44'), Godfrey Island (46°09', 82°42'), and Mills Island-David Island (46°08', 82°41'). The last reported spawning was in 1940.

Portage Point (45°53', 82°46'). Minor ground; spawning occurred over broken rock and round stones at depths of 12-30 ft on October 10-30; the last reported spawning was in 1940.

Barrie Island (45°55', 82°40'). Minor ground; spawning occurred at Creighton Point (45°57', 82°42') and Fishery Point (45°56', 82°44') over broken rock, gravel, and round stones at depths of 12-36 ft on October 10-20; the last reported spawning was in 1940. Heron Patch (45°59', 82°42') to Jubilee Shoal (45°58', 82°44') was a major ground, where spawning occurred over 1,040 acres of gravel and round stones at depths of 12-72 ft on October 10-20.

NC-2

Acadia Rock (46°07', 82°40'), west end of Dewdney Island (46°08', 82°39'), and shoal (46°07', 82°37') southeast of Dewdney Island. Minor spawning grounds.

Restless Bank (46°04', 82°35'). Minor ground; spawning occurred over 640 acres of gravel and round stones at depths of 24-60 ft on October 10-November 10; the last reported spawning was in 1942.

Julia Point (45°58', 82°37'). Minor ground; the last reported spawning was in 1940.

Julia Bay (45°56', 82°33'). Minor ground; spawning occurred at 45°55', 82°34' over broken rock, gravel, and round stones at depths of 12-24 ft on October 10-30; the last reported spawning was in 1940.

Rob Roy Patch (46°04', 82°32')--Darch Island (46°04', 82°24'). Spawning occurred over 3,520 acres of gravel and round stones at depths of 12-60 ft on October 10-November 10; the last reported spawning was in 1942.

Innes Island (46°04', 82°20'). Minor ground; spawning occurred at 46°03', 82°22' over 800 acres of round stones and gravel at depths of 12-60 ft on October 10- November 10; the last reported spawning was in 1942.

Bear's Back Island and Shoal (46°01', 82°07'). Spawning occurred over 1,600 acres of round stones at depths of 12-60 ft on October 10-November 10; the last reported spawning was in 1942.

Wabos Island (45°57', 82°05'). Minor ground; spawning occurred over 240 acres of honeycombed rock at depths of 12-36 ft on October 18-November 10; the last reported spawning was in 1950.

Bedford (46°02', 82°03') and West Rous (46°01', 82°01') Islands. Spawning occurred south of the islands over 600 acres of round stones at depths of 12-36 ft on October 18-November 10; the last reported spawning was in 1950.

Five Island (46°03', 82°00'). Minor ground; spawning occurred along the north side over 160 acres of round stones at depths of 12-60 ft on October 18-November 10; the last reported spawning was in 1950.

Great La Cloche Island (46°02', 81°53'). Spawning occurred along the northwest shore (46°03', 81°55') over 720 acres of honeycombed rock and round stones at depths of 12-60 ft on October 18-November 10; the last reported spawning was in 1950.

NC-3

McGregor Bay (46°01', 81°43'). Minor ground; spawning occurred at the small islands at the entrance of the bay over 320 acres of round stones at depths of 12-36 ft on October 19-November 10; last reported spawning was in 1950.

McGregor Point (46°00', 81°42')--Frazer Bay (45°58', 81°38'). Spawning occurred over 960 acres of sand and patches of round stones at depths of 12-60 ft on October 18-November 10; the last reported spawning was in 1950.

Frazer Bay (45°58', 81°38'). Spawning occurred along the south shore over 960 acres of sand and patches of round stones at depths of 18-90 ft on October 10-November 10; the last reported spawning was in 1950.

South Shore of Great La Cloche Island (46°02', 81°53')--Mary Islands (45°58', 81°46'). Spawning occurred over 2,560 acres of honeycombed rock and round stones at depths of 12-48 ft on October 18-November 10; last reported spawning was in 1950.

Heywood Island (45°56', 81°46'). Spawning occurred over 480 acres of round stones at depths of 12-48 ft on October 18-November 10; the last reported spawning was in 1950.

East Point (45°56', 81°50') on Strawberry Island (45°56', 81°52')--Beaver Island Bank (45°54', 81°52'). Spawning occurred over 320 acres of round stones at depths of 12-36 ft on October 18-November 10; the last reported spawning was in 1950. Spawning was completed at Sheguiandah (45°54', 81°55') by November 10 (Ont. Game Fish 1913b).

Boulton Reef (45°54', 81°51')--McGregor Bank (45°54', 81°51'). Spawning occurred over 640 acres of honeycombed rock and round stones at depths of 12-36 ft on October 18-November 10; the last reported spawning was in 1950.

GB-1

Kokanongwi Shingle (45°56', 81°34'). Minor ground; spawning occurred over gravel and round stones at depths of 12-54 ft on October 25-November 12; the last reported spawning was in 1940.

Papoose Island (45°51', 81°21'). Major ground; spawning occurred south and southwest of the island (at 45°50', 81°22') over 960 acres of honeycombed rock at depths of 18-60 ft on October 25-November 12; the last reported spawning was in 1940.

Azov Ledges (45°49', 81°29'). Major ground; spawning occurred south of Squaw Island (45°50', 81°27') over 2,160 acres of honeycombed rock at depths of 18-54 ft on October 25-November 12; the last reported spawning was in 1940.

Smith Bay (45°48', 81°40'). Minor ground; spawning occurred at Goldhunter Rock (45°49', 81°37'), Doyle Rock (45°49', 81°38'), Pelkie Rock

(45°50', 81°37'), West Mound (45°50', 81°39'), and William Island (45°51', 81°38') to Hog Island (45°52', 81°38') over honeycombed rock at depths of 18-54 ft on October 25-November 12. The last reported spawning was in 1940.

Philip Edward Island (45°59', 81°15'). Minor ground; spawning occurred at Green Island (45°54', 81°20'), Scarecrow Island (45°54', 81°23'), and Harty Patches and the Brothers (45°57', 81°23') over round stones at depths of 18-78 ft on October 25-November 12; the last reported spawning was in 1940.

Collins Inlet (45°59', 81°25')--French River (45°56', 80°54'). Thousands of fish were caught in this area during the spawning season in mid-October (Kerr and Kerr 1860-1898).

Riley Patch (45°42', 81°19'). Major ground; spawning occurred over 1,600 acres of honeycombed rock at depths of 24-96 ft during October to mid-November; the last reported spawning was in 1940.

McNeil Ledge (45°43', 81°15'). Major ground; spawning occurred over 1,920 acres of honeycombed rock at depths of 30-90 ft on October 25-November 12; the last reported spawning was in 1940. Minor spawning grounds existed near the ledge at 45°45', 81°15'; 45°46', 81°16'; and 45°47', 81°15' on small "lumps" of honeycombed rock. Major grounds existed west and southwest of the ledge at Milligan Rock (45°41', 81°17'), Ben Back Shoal (45°41', 81°18'), and Tranch Rock (45°40', 81°20'); spawning occurred over honeycombed rock at depths of about 24-84 ft in October to mid-November. The last reported spawning was in 1940.

Dawson Rock (45°38', 81°16'). Major ground; spawning occurred in October to mid-November over honeycombed rock on the west side of the rock at 45°38', 81°16' at depths of 12-42 ft, and 1 mi N-NW of the rock at 45°40', 81°17' at depths of 36-78 ft; the last reported spawning was in 1940.

Northeast Shingle (45°37', 81°24'). The west side was a major ground. Spawning occurred over honeycombed rock at depths of 12-42 ft in October; the last reported spawning was in 1945.

Lonely Island (45°34', 81°28'). The east side was a major ground. Spawning occurred over honeycombed rock at depths of 12-48 ft in October; the last reported spawning was in 1945.

Rabbit Island Bank (45°37', 81°40'). Minor ground; spawning occurred over honeycombed rock at depths of 12-30 ft in October; the last reported spawning was in 1945.

Stewart Rock (45°30', 81°49')--Ship Bank (45°30', 81°50'). Major ground; spawning apparently ended in 1939.

Club Island Ledge (45°33', 81°36'). Minor ground; spawning occurred over honeycombed rock at depths of 12-30 ft in October; the last reported spawning was in 1945.

GB-2

McCarthy Point Ledge (45°27', 81°45'). Minor ground; the last reported spawning was in 1945.

Anderson Ledge (45°24', 81°44')--White Shingle (45°21', 81°40'). Major ground; spawning occurred over 4,800 acres of honeycombed rock at depths of 12-72 ft in October; the last reported spawning was in 1945.

Halfmoon Island (45°26', 81°28'). Major ground; spawning occurred on the south side over honeycombed rock at depths of 18-48 ft in October; the last reported spawning was in 1945.

Darling Reef (45°09', 81°14'). Major ground; spawning occurred over 400 acres of honeycombed rock at depths of 18-48 ft on October 10-November 10; the last reported spawning was in 1950.

Cape Chin (45°07', 81°17')--Smoky Head (45°05', 81°16'). Major ground; spawning occurred over 3,020 acres of honeycombed rock at depths of 18-114 ft on October-November 10; the last reported spawning was in 1950.

Lion's Head (45°00', 81°13')--Jackson Shoal (45°02', 81°11'). Major ground; spawning occurred over 2,000 acres of honeycombed rock at depths of 12-120 ft on October 10-November 31; the last reported spawning was in 1950.

GB-3

Bustard Islands (45°53', 80°55'). Minor ground; spawning occurred over 2,800 acres of round stones and broken rock at depths of 24-66 ft.

Cunningham (north shore of Georgian Bay, location uncertain). In 1910, lake trout first appeared on the shoals on October 17 (Ont. Game Fish 1911).

Kennedy Bank (45°30', 80°41'). Major ground; spawning occurred over 9,600 acres of honeycombed rock at depths of 18-96 ft on October 25-November 10; the last reported spawning was in 1946.

Stalker Bank (45°26', 80°36'). Major ground; spawning occurred over honeycombed rock at depths of 18-60 ft on October 20-November 18; the last reported spawning was in 1946.

Haggart Island (45°25', 80°23'). Minor ground; spawning occurred over round stones at depths of 18-30 ft on October 20-November 18; the last spawning reported by Smith (1968) was in 1946. In the 1970s, stocked lake trout were reported spawning in the same area at 45°26', 80°24' (Environ. Can. 1977c).

Long Bank (45°23', 80°37'). Major ground; spawning occurred over 5,760 acres of honeycombed rock at depths of 36-66 ft on October 20-November 18; spawners were also taken west of Long Bank at 45°25', 80°39' over honeycombed rock at depths of 42-54 ft on October 20-November 18. The last reported spawning at these two locations was in 1946.

Limestone Islands (45°24', 80°32'). Spawning occurred at South Limestone Bank (45°22', 80°34'), at an area south of North Limestone Island (45°25', 80°32'), and from North Limestone Island to Midland Bank (45°26', 80°32'), over broken bottom and honeycombed rock at depths of 12-48 ft on October 20-November 18.

Snake Bank (45°20', 80°22'). Minor ground; spawning occurred here over round stones at depths of 12-72 ft on October 20-November 18; the last reported spawning was in 1946.

Sequin Bank (45°19', 80°31'). Major ground; spawning occurred here over honeycombed rock at depths of 18-54 ft on October 20-November 18; the last reported spawning was in 1946.

Araxes Bank (45°17', 80°20'). Minor ground; spawning occurred here over broken bottom and round stones at depths of 12-30 ft on October 20-November 18; the last reported spawning was in 1946.

Umbrella Ledges (45°12', 80°15'). Minor ground; spawning occurred here over honeycombed rock and broken substrate at depths of 24-114 ft on October 20-November 18; the last reported spawning was in 1940.

GB-4

Lake trout were protected during the spawning season in an area south of a line from Gidley Point (44°45', 80°07') to Cape Commodore (44°48', 80°54') (Ont. Min. Lands Forests 1950).

Watcher Reef (44°57', 80°05'). Minor ground; spawning occurred here at depths of 18-60 ft.

Christian Island (44°50', 80°12'). Minor ground; spawning occurred on the northwest shore of the island at depths of 6-120 ft.

Collingwood (44°30', 80°13'). Major ground; spawning occurred near Collingwood at 44°35', 80°16'; 44°32', 80°13'; and 44°31', 80°12' over gravel at depths of 18-60 ft.

Collingwood (44°30', 80°13')--Thornbury (44°34', 80°27'). Major ground; spawning occurred at 44°36', 80°23', northwest of Mary Ward Ledges over 2,800 acres of gravel and broken rock at depths of 30-60 ft, and at 44°36', 80°21' and 44°36', 80°20' over gravel at depths of 24-54 ft on October 25-November 15; the last reported spawning was in 1945.

Thornbury (44°34', 80°27'). Spawning occurred near Thornbury (Ont. Game Fish 1911, 1912).

Boucher (44°37', 80°30')--Meaford (44°37', 80°35'). This shoreline supported limited spawning over 768 acres of honeycombed rock at depths of 18-54 ft on October 25-November 15; the last reported spawning was in 1945.

Cape Rich (44°43', 80°38')--Coffin Hill (44°40', 80°50'). Major ground. Spawning occurred near Cape Rich at 44°47', 80°41'; 44°45', 80°36'; 44°45', 80°34'; 44°45', 80°31'; and 44°43', 80°30'. Spawning occurred at these locations, the largest of which covered 4,480 acres, over honeycombed rock at depths of 72-120 ft during October 15-November 15; the last reported spawning was in 1945. Vail Point was historically considered the best place to obtain lake trout spawn in late October (Kerr and Kerr 1860-1898). Spawning occurred over 8,000 acres (44°44', 80°43') of gravel and honeycomb at Vail Point (44°43', 80°45') at depths of 12-96 ft on October 15-November 15; the last reported spawning was in 1945. Considerable spawning also occurred on a 1,400 acre area (44°45', 80°46') of honeycombed rock, 1-1/2 mi NW of Vail Point, on October 15-November 15.

Pyette Point (44°44', 80°53')--Cape Commodore (44°48', 80°54'). Minor ground; spawning occurred over an area of 1,520 acres of round stones and honeycombed rock at depths of 24-120 ft on October 10-31; the last reported spawning was in 1945.

Islands off Colpoys Bay (44°50', 80°57'). Major spawning grounds were located on the east side of Hay Island (44°53', 80°58'), the east side of White Cloud Island (44°50', 80°58'), the east side of Griffith Island (44°50', 80°54'), and Gunderson Shoal (44°49', 81°01'); spawning occurred over honeycombed rock and round stones at depths of 18-20 ft on October 10-31. Spawning apparently occurred at least until 1950, when ripe, spawning, and spent males and females were captured over clean, honeycombed rock at depths of 42-90 ft around White Cloud Island (Smith 1968); this run peaked on about November 10-11 (Tomkins 1951). Spawn was collected at a site about 9 mi from Wiarton in November, this was probably near White Cloud Island (44°50', 80°58') (Can. Dep. Mar. Fish 1905).

Colpoys Bay (44°47', 81°05'). Many lake trout were caught in the bay during November (Kerr and Kerr 1860-1898), and the bay was classified as a "reserve" ground (Ont. Game Fish 1932). There were several spawning areas in the bay. Wiarton Harbor (44°45', 81°09') was a minor spawning ground; spawning occurred until 1950 over 1,120 acres of mud at depths of 30-78 ft in October (Smith 1968).

Town of Cape Croker (44°55', 81°01')--Cape Paulett (44°55', 81°06'). Major ground; spawning occurred over 20,160 acres of honeycombed rock at depths of 18-144 ft on October 10-November 10; the last reported spawning was in 1950.

Cape Dundas (44°58', 81°08'). Major ground; spawning occurred over 1,040 acres of honeycombed rock at depths of 18-104 ft on October 10-November 10; the last reported spawning was in 1950.

Surprise Shoal (45°04', 81°01'). Major ground; spawning occurred over 360 acres of honeycombed rock at depths of 12-66 ft on October 10-November 10; the last reported spawning was in 1950.

SPLAKE

Splake (brook trout x lake trout hybrid) have been stocked in Lake Huron since 1954. Splake usually spawn in late fall on rocky shoals (OMNR 1973). Ripe adults have been collected over former lake trout spawning grounds (GLFC 1970a).

Michigan

MH-1

Calcite Harbor (45°25', 83°46'). Many mature splake enter the harbor in October, presumably to attempt to spawn on the shoreline and breakwalls (FWS 1979d).

MH-2

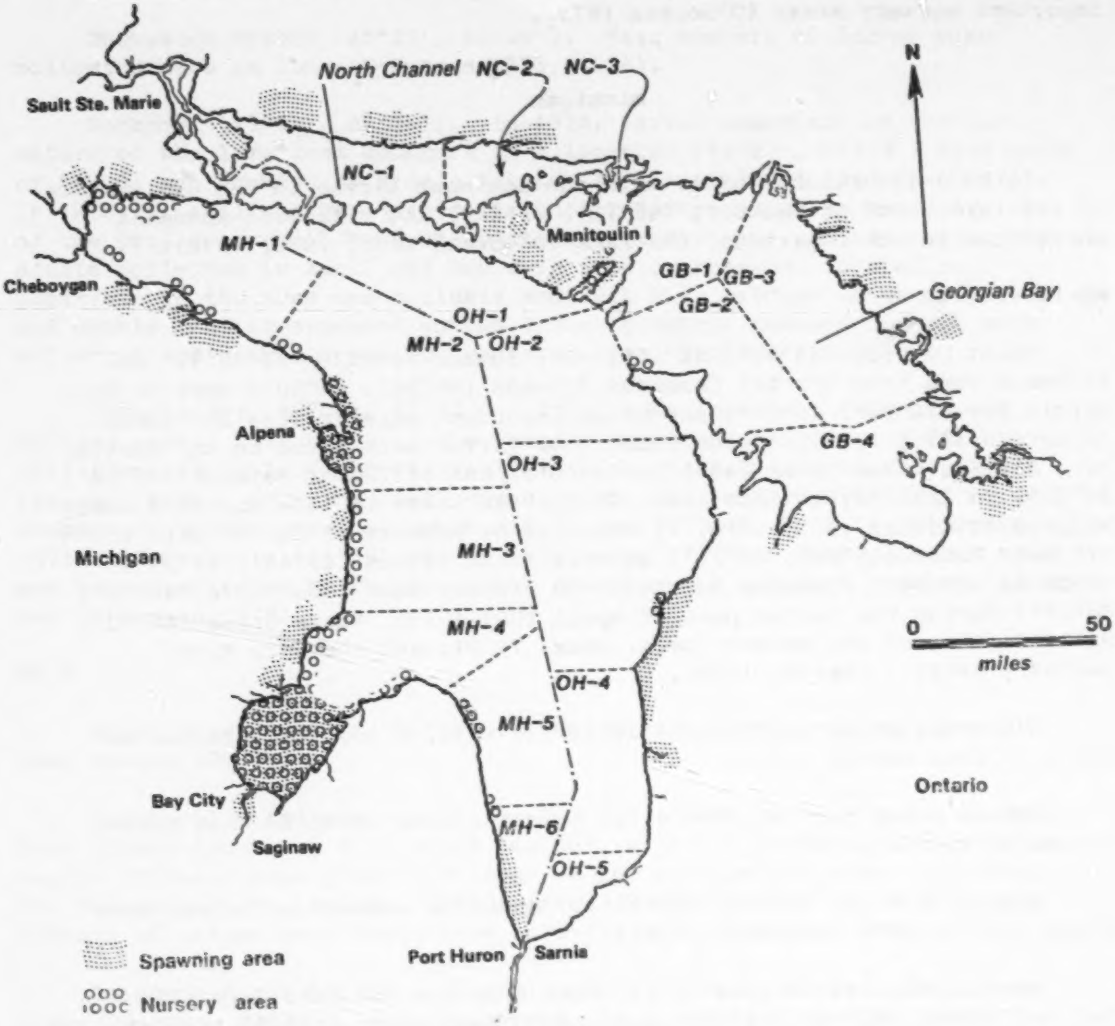
Rockport (45°12', 83°23'). Since about 1974, splake have spawned just off Rockport on a small reef in 6-10 ft of water (Organ et al. 1978).

Ontario

OH-1

Manitoulin Island (45°50', 82°30'). Ripe and running adults have been captured in mid-October over former lake trout spawning grounds in Burnt Island Bay (45°50', 82°57') at depths of about 3-6 ft and temperatures of about 54-57°F (Berst and Spangler 1970b).

RAINBOW SMELT


North Channel
NC-1
NC-2
NC-3
N
Sault Ste. Marie
Manitoulin I
MH-1
Cheboygan
GB-1
GB-2
GB-3
Georgian Bay
OH-1
MH-2
OH-2
Alpena
GB-4
OH-3
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Ontario
Bay City
Saginaw
MH-6
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

Rainbow smelt eggs planted in Crystal Lake (44°40', 86°10') (Lake Michigan drainage) in 1912 are believed to be the source of the smelt population found in all the Great Lakes except Lake Ontario. Smelt were first reported in Lake Huron off Rogers City (45°25', 83°49'), Michigan, in 1925. Records of dispersal suggest that this species entered Lake Huron from Lake Michigan (Van Oosten 1937a).

Spawning runs of rainbow smelt occur in most tributaries to Lake Huron. The runs usually begin around the second week of April, peak in the third or fourth week of April, and continue possibly through the first week of May (Van Oosten 1953). Hatching occurs in mid-May to early June, and, as they grow, the young disperse from the nearshore areas (O'Gorman 1976). The nearshore areas off irregular coastlines seem to be the most important nursery areas (O'Gorman 1979).

Michigan

In 1973-75, rainbow smelt were the dominant larvae in the U.S. waters of the lake north of Rockport (45°12', 83°23') and were more abundant there than in other parts of the lake (O'Gorman 1975, 1976, 1978).

MH-1

Point De Tour (45°57', 83°55')--St. Ignace (45°52', 84°43'). The littoral zone from the Les Cheneaux Islands (45°58', 84°20') west to St. Martin Bay (46°00', 84°37') may be an important nursery area for smelt (O'Gorman 1976, 1978). Large numbers of larvae were found in St. Martin Bay, off St. Vital Point (45°57', 84°00'), and off Point Fuyards (45°56', 84°23') in late May to late June; the larvae taken in late May were newly hatched (O'Gorman 1975, 1976, 1978). Lesser numbers of larvae were found off Zela Point (45°46', 84°31') on Bois Blanc Island (45°46', 84°27') (O'Gorman 1976). Spawning runs entered streams near Cedarville (46°00', 84°21') during the latter part of April (UPI 1979), Nunns Creek (46°02', 84°34') (Gleason and Behmer, pers. comm. 1979), and the Carp River (46°02', 84°41') (Warner 1979).

Cheboygan River (45°39', 84°28'). In 1936, a good run started on April 11 (Van Oosten 1937a).

Greene Creek (45°38', 84°14'). Spawning runs occur in this stream (Hunn, pers. comm. 1980).

Nine Mile Point (45°38', 84°13'). Moderate numbers of larvae were found here in 1974 (O'Gorman 1976).

Hammond Bay (45°30', 84°05'). Runs from the bay into Carp (Black Mallard) Creek (45°32', 84°07') and the Ocqueoc River (45°29', 84°04') began in 1936 (Van Oosten 1937a); these have continued through the 1940s (Applegate 1950) to the present (FWS 1979c; Hunn, pers. comm. 1979). Runs in these tributaries usually peaked during the latter part of April (Applegate 1950). Hammond Bay also is a nursery area for smelt. Moderate to large numbers of larvae were found here in mid-June (O'Gorman 1975, 1976, 1978).

Eagle Creek (location unknown), Schmidt Creek (45°29', 83°56'), and Nagels Creek (45°27', 83°52'). Spawning runs occur in these streams and most of the streams north of Rogers City (45°25', 83°49') (Hunn, pers. comm. 1980).

MH-2

Thompsons Harbor (45°21', 83°36'). Fair numbers of larvae were collected here in June (O'Gorman 1975, 1976).

Rockport (45°12', 83°23'). In 1974, larval abundance in the U.S. waters of the lake from Rockport to a location (44°27', 83°19') just north of Oscoda was highest at Middle Island (45°11', 83°20') (O'Gorman 1976). In 1978-79, smelt larvae were collected at Rockport during May-July; 62% of the prolarvae and 57% of the postlarvae taken were rainbow smelt. Most adults collected in April and May were ripe or running. Shoreline substrate in the area was boulders and rock with patches of sand, gravel, and cobble, and it appeared suitable for spawning; however no eggs were collected and spawning was not observed (Tex. Instrum. 1979c).

Thunder Bay (45°00', 83°20'). This is an important spawning and nursery area. Runs began in the Thunder Bay River (45°03', 83°26') in 1932 (Creaser 1932; Van Oosten 1937a) and have continued to the present (Warner 1979). Spawning also occurs in the bay (O'Gorman 1978). Large numbers of larvae were collected off Alpena (45°04', 83°26') (O'Gorman 1975) and Ossineke (44°55', 83°25') (O'Gorman 1978). Young rainbow smelt may be concentrated in shallow areas of the south and west portions of the bay (O'Gorman 1978).

MH-3

Black River (44°49', 83°18'). The first run occurred here in 1935 (Van Oosten 1937a).

Harrisville (44°40', 83°18'). In 1936, spawning runs began in Mill Pond Stream (possibly Mill Creek [44°40', 83°17']) in Alcona County (Van Oosten 1937a). Runs presently occur in the Harrisville area, including the Sturgeon Point (44°43', 83°16') area (Warner 1979). In 1975, large numbers of larvae were found here in early June (O'Gorman 1978).

Au Sable River (44°24', 83°19'). In 1935, runs began in Van Etten Creek (44°26', 83°20'), a tributary of the Au Sable River (Van Oosten 1937a). Runs still occur at the Au Sable River mouth (Warner 1979).

MH-4

Saginaw Bay (44°00', 83°30'). Rainbow smelt spawn in the inner portion of the bay, and larval abundance usually peaks in late May or early June (O'Gorman 1978). In 1956, young-of-the-year (YOY) were numerous from July to October in the inner bay and shallow areas of the outer bay (Carr 1962).

Au Sable Point (44°20', 83°20'). Fair numbers of larvae were found here in June and July 1973-1975 (O'Gorman 1975, 1976, 1978).

Tawas River (44°16', 83°31'). Heavy runs into the Tawas River began in 1935 (Van Oosten 1937) and have continued to the present; these runs usually occur in late April (North Woods Call 1979a; UPI 1979; Warner 1979).

Whitney Drain (diverted East Branch of Au Gres River (44°09', 83°34'). Heavy runs occur usually in mid-to late April (UPI 1979; Warner 1979). Spawning may have occurred along the beaches in the area in 1979 when low temperatures aborted runs into the river (North Woods Call 1979c).

Alabaster (44°11', 83°33'). In 1979, adults were most abundant in April, and in May some were running-ripe. The gravel substrate appeared suitable for spawning, but no eggs were collected and no spawning was observed (Tex. Instrum. 1979d). Rainbow smelt larvae were collected in May and June and were more numerous than those of most other species; 20% of total prolarvae and 52% of total postlarvae collected were rainbow smelt (Tex. Instrum. 1979b,d).

Au Gres River (44°02', 83°41'). Runs began here in 1935 (Van Oosten 1937a). The area from Point Lookout (44°03', 83°35') to Point Au Gres (43°59', 83°41') is an important nursery area for smelt (O'Gorman 1978). In 1973, large numbers of larvae were found off Point Au Gres in mid-June (O'Gorman 1975). In 1956, many YOY were also present in July and August at Point Lookout and Point Au Gres (Gordon 1957, 1961).

Point Au Gres (43°59', 83°41')--Saganing Bar (43°55', 83°51'). Spawning occurred generally throughout this area in shallow water over a bottom of mud and stone just after ice breakup; Wigwam Bay (43°59', 83°50), was identified as a spawning site (Organ et al. 1978).

Saginaw River (43°39', 83°51'). Runs occur in late April, although in 1976 only a few ripe and spent adults were collected (Beak Consult. 1976). At the Karn-Weadock Power Plant Complex (43°39', 83°51'), at the river mouth, eggs were entrained in mid-late March, and larvae were entrained in mid-May (Consumers Power 1976c,d).

Quanicasse (43°35', 83°40'). Rainbow smelt postlarvae were collected at the site of the Quanicasse Power Plant from May to July; rainbow smelt made up 2.4% of the total catch of postlarvae (Tex. Instrum. 1979b,e).

Port Austin (44°03', 83°00'). In 1975, large numbers of larvae were collected here; greater concentrations of larvae were generally encountered along the south shore of the outer bay than along the north shore (O'Gorman 1978).

MH-5

Runs enter various small tributaries all along the Thumb area (44°03', 82°52'--43°00', 82°25') (Warner 1979).

Harbor Beach (43°51', 82°39'). In the southern part of the lake, the largest numbers of larvae were taken off Harbor Beach in June to July (O'Gorman 1975, 1978). Running ripe adults and eggs were captured from the harbor north for 5 mi to an unnamed location (43°54', 82°41') to depths of about 45 ft; the substrate was boulders and large rocks (LaJeone, pers. comm. 1979).

MH-6

Richmondville (43°34', 82°36'). Larvae were found here in 1973 but were about half as abundant as at Harbor Beach (43°51', 82°39') (O'Gorman 1975).

Port Sanilac (43°26', 82°32')--Port Huron (43°00', 82°26'). Runs occur at Port Sanilac (UPI 1979) and in the entire area from Port Sanilac south to Port Huron (Warner 1979). Commercial fishermen reported that smelt were abundant on the beaches along the southwest shore of the lake in the spring (Organ et al. 1978).

Ontario

In 1934, the first runs were recorded in Georgian Bay tributaries (Dymond 1944), and by 1941, runs were occurring in every stream along the shoreline of the bay and in most of the tributaries of Lake Huron proper (Dymond 1944; Van Oosten 1953).

OH-1

Lonely Bay Creek (45°42', 82°20') and Dean Bay Creek (45°41', 82°19'). Rainbow smelt first appeared in these streams in 1932 (Dymond 1944).

Manitou River (45°36', 82°06'). Some rainbow smelt were collected in the CDFO sea lamprey weir in 1969 (FWS 1979c) and runs may occur.

South Bay (45°38', 81°52'). In 1948, runs from the bay entered Cornell Creek (45°40', 81°53'), McLennan's Creek (45°41', 81°51'), Peltier Freshet (45°42', 81°46'), Trudeau Creek (45°41', 81°45'), Pheasant Creek (45°40', 81°45'), and School Freshet (45°39', 81°48'). The runs usually stopped within 1/4 mi of the bay, at the first falls with a drop of more than 1 ft. Heavy runs began on April 14, the day after ice breakup on the bay, but did not occur in one small stream until late April. The runs were believed to be composed almost entirely of fish from a resident stock in the bay (Baldwin 1950). During 1964-68, larvae were abundant in the bay beginning in early May. Larvae quickly moved away from the shoreline areas and within several days were dispersed throughout the surface waters of the inner basin (Faber 1964, 1970).

OH-3

Port Elgin (44°26', 81°24')--Port Albert (43°53', 81°43'). Most streams in this region have runs (Dymond 1944). Eggs have been entrained at the Bruce Generating Station at Douglas Point (44°19', 81°36'); rainbow smelt larvae and YOY are more abundant than those of most other species at Douglas Point and Baie du Bore (44°21', 81°34') from mid-May throughout the summer (Dunford 1978b; Dunstall 1978a; Kelso and Leslie 1979).

OH-4

Nine-mile Creek (at Port Albert 43°53', 81°43') and Maitland River (43°45', 81°44'). Runs occur in these streams (Dymond 1944).

NC-1

St. Joseph Island (46°13', 84°00'). In 1934, runs occurred in several small unnamed streams (Dymond 1944; Savage 1935).

MacBeth Creek (46°17', 83°37'). In 1933, runs entered the creek in mid-April to mid-May (Savage 1935).

Thessalon River (46°15', 83°34'). Runs occurred in mid-April to mid-May 1933 (Savage 1935) and in mid to late April 1941 (Dymond 1944).

Livingstone Creek (46°15', 83°29'), Mississagi River (46°10', 83°01'), and Blind River (46°11', 82°57'). In 1933, runs entered these creeks in mid-April to mid-May (Savage 1935).

Algoma Creek (46°11', 82°49'), One of the first runs on the north shore occurred in this stream in early April 1932 (Savage 1935).

Lawgon Creek (location unknown, possibly Lauzon Creek [46°11', 82°49']). Runs occurred in mid-April to mid-May 1933 (Savage 1935) and in mid- to late April 1941 (Dymond 1944).

Serpent River (45°13', 82°37'). In 1933, runs entered the river in mid-April to mid-May (Savage 1935).

Shepherd (Sheppard) Creek (46°13', 82°36') One of the first runs on the north shore occurred in this stream in early April 1932 (Savage 1935).

NC-2

Spanish River (46°11', 82°19'). The first run here occurred in 1937 (Dymond 1944).

Gore Bay Creek (45°55', 82°28'). Rainbow smelt first spawned here in 1933 (Dymond 1944).

Kagawong River (45°54', 82°15'). The first run occurred here in 1934 (Dymond 1944); in 1941, the run began in early April (Dymond 1944).

GB-2

Dunks Bay (45°15', 81°38'). Rainbow smelt larvae are common here in spring and summer at depths of 7-13 ft (Emery 1973).

GB-3

Magnetawan River (45°46', 80°38'). Runs here began in 1936 (Dymond 1944).

Pointe au Baril (45°34', 80°30'). In 1936, runs began in many small streams near here, usually in mid-April (Dymond 1941).

Shawanaga River (45°32', 80°23'). The first run here occurred in 1938 (Dymond 1944).

Sequin River (45°20', 80°02'). The first run here occurred in 1938 (Dymond 1944; Environ. Can. 1977c).

GB-4

Port Severn (44°48', 79°43'). In 1938, the first runs near here occurred in a small unnamed stream (Dymond 1944).

North River (44°44', 79°39'). Runs here were first reported in 1938 (Dymond 1944).

Coldwater River (44°44', 79°39'). A run occurred here in 1941, beginning in mid-April (Dymond 1944).

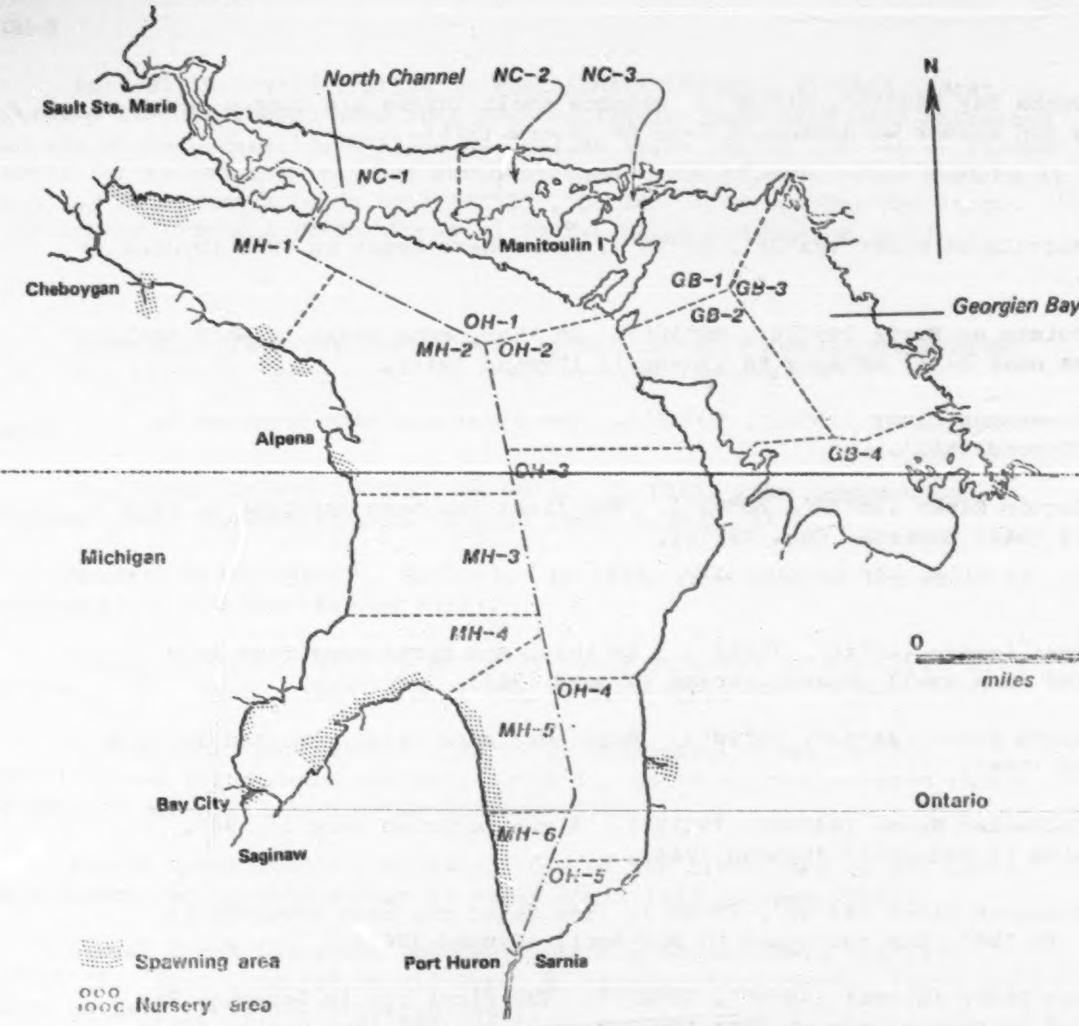
Sturgeon River (44°44', 79°44'). The first run here occurred in 1938. In 1941, the run began in mid-April (Dymond 1944).

Hog River (Creek) (44°45', 79°47'). The first run in Georgian Bay occurred in this stream in 1934 (Dymond 1944) or 1935 (Van Oosten 1937a, 1953). In 1941, the runs began in mid-April (Dymond 1944).

Sucker Creek (44°48', 79°53'). The first runs here occurred in 1936 (Dymond 1944).

Owen Sound area (44°40', 80°53'). Runs occurred here in 1941, beginning in early April (Dymond 1944).

NORTHERN PIKE


North Channel
NC-2
NC-3
NC-1
N
Sault Ste. Marie
Cheboygan
MH-1
Manitoulin I
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
OH-3
GB-4
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Bay City
Ontario
Saginaw
MH-6
OH-5
Spawning area
Port Huron
Sarnia
Nursery area

Michigan

MH-1

St. Martin Bay (46°00', 84°37')--Les Cheneaux Islands (45°58', 84°20'). Spawning has occurred since the 1950s from the mouth of the Pine River (46°03', 84°39') in St. Martin Bay eastward throughout the Les Cheneaux Islands and Dudley Bay (45°59', 84°09'). Spawning occurs over mud and aquatic vegetation at depths of 6 ft or less in May (Organ et al. 1978).

Cheboygan River (45°39', 84°28'). In 1929-33, adults were collected at the mouth of the river during the spawning migration, which usually occurred in April; a dam near the river mouth blocked upstream movement (Shetter 1937). Presently, northern pike spawn near the mouth of the Cheboygan River on both sides of the river and also in Duncan Bay (45°39' 84°26') (Stedman, pers. comm. 1979).

Rogers City (45°25', 83°49'). Spawning occurred in "open gaps" in the rock along the harbor (Organ et al. 1978).

Calcite Harbor (45°25', 83°46'). Large spawning runs enter streams southeast of the harbor (FWS 1979d).

MH-2

Grand Lake outlet (45°21', 83°34'). Northern pike migrate to the marshes below Grand Lake (45°18', 83°30') to spawn (Hunn, pers. comm. 1980).

Thunder Bay (45°00', 83°20'). In the 1920s-1960s, spawning occurred from Sulphur Island (44°59', 83°25') southeast for about 6 mi over mud and rock at depths of 12-24 ft (Organ et al. 1978). Excellent spawning habitat also exists in the Squaw Bay marsh (45°00', 83°27'), in the reeds along the south shore of Squaw Bay, and along the south shore of Thunder Bay (at 44°54', 83°20'); spawning probably occurs in these areas (Stedman, pers. comm. 1979).

MH-4

Saginaw Bay (44°00', 83°30'). Spawning occurs just after ice breakup in several shallow areas in the bay (Organ et al. 1978).

Wigwam Bay (43°59', 83°50')--Pinconning Bar (43°51', 83°52'). Spawning occurs in this area in very shallow water and also in a small area (44°00', 83°43') about 1 mi E of Wigwam Bay over mud (Organ et al. 1978).

Saginaw River (43°39', 83°51'). In 1975-76, spawning probably occurred in the vicinity of the Karn-Weadock Power Plant Complex (43°39', 83°51') at the river mouth. Ripe fish were caught in the bay on March 9-13, both ripe and spent fish were caught in the bay and river on April 21-30, and spent fish were caught on May 17-23. The river bayous provide excellent potential spawning habitat (Beak Consult. 1976).

Fish Point (43°43', 83°31')--east of Hat Point (44°00', 83°05'). Most of the spawning sites identified in Saginaw Bay were along the east shore in this area. All sites are currently used, and the catch of spawners dates back to 1915. The substrate is mud, sand, clay, and vegetation (Organ et al. 1978).

MH-5, MH-6

Pointe aux Barques Light (44°01', 82°48')--south of Lakeport (43°04', 82°28'). Spawning occurred during 1917-69 along the entire shoreline at depths of about 20 ft. Substrate, where identified, was a combination of clay, mud, sand, and rock (Organ et al. 1978).

Ontario

OH-4

Maitland River (43°45', 81°44'). Spawning occurs in the river (Moccia, pers. comm. 1979).

GB-4

Matchedash Bay (44°46', 79°42'). Spawning occurs in the bay (Environ. Can. 1977c). In 1931, it was recommended that the southeastern portion of Georgian Bay that was closed to commercial fishing be enlarged to provide a "spawning sanctuary" (Ont. Game Fish 1931).

MUSKELLUNGE

Michigan

MH-1

Cheboygan River (45°39', 84°28'). In 1929-33, a few muskellunge were captured in the spring during the spawning run at the mouth of the river; a dam near the river mouth blocked upstream movement (Shetter 1937).

Ontario

GB-4

Matchedash Bay (44°46', 79°42'). Spawning occurs here (Environ. Can. 1977c). Spawning has occurred in the southeastern portion of Georgian Bay for a number of years. In 1931, it was recommended that the southeastern part of the bay that was closed to commercial fishing be enlarged to provide a "spawning sanctuary" (Ont. Game Fish 1931).

GOLDFISH

No information was found concerning the introduction of goldfish into Lake Huron.

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Commercial fishermen reported that spawning occurs in the area from Wigwam Bay (43°59', 83°50') to Saganing Bar (43°55', 83°51') over sand, clay, and vegetation to a depth of about 10 ft (Organ et al. 1978).

LAKE CHUB

Michigan

MH-1

Carp (Black Mallard) Creek (45°32', 84°07'). Spawning runs were reported here during the late 1940s; the runs consistently peaked in May, usually during and just after those of the white sucker and sea lamprey (Applegate 1950).

Ontario

The lake chub was believed to be common during the spawning season all along the Ontario shore and in the coastal streams (Hubbs and Brown 1929).

CARP

The initial plantings of carp were made in the inland waters of the U.S. in 1831. Carp were first observed in Lake Huron in 1900 at the entrance to the St. Clair River. Presumably these fish originated from St. Clair River and Lake St. Clair populations. Carp were first reported in Georgian Bay (45°30', 81°00') in 1905, near the mouth of the Trent Canal (Trent-Severn Waterway) (44°47', 79°44'). These Georgian Bay fish probably originated from the Lake Simcoe population that migrated through the Trent Canal (McCrimmon 1968). Carp inhabit the littoral zone of the lake and move into marshy areas in the spring to spawn (Berst and Spangler 1970a).

Michigan

MH-1

Hammond Bay (45°30', 84°05'). Carp spawn off the point at the Hammond Bay Biological Station (45°30', 84°02'); spawning occurs over large rock rubble in shallow water, when the water temperature exceeds 55°F, usually in June. Ocqueoc River (45°29', 84°04'). Carp migrate up the Ocqueoc River to spawn (Hunn, pers. comm. 1979).

MH-2

Stoneport (45°18', 83°26'). Spawning occurs in the Stoneport-Presque Isle (45°21', 83°29') area (Hunn, pers. comm. 1980).

MH-4

Saginaw Bay (44°00', 83°30'). According to commercial fishermen, carp spawn extensively in the bay during May-July; the exact timing depends on water temperature (Organ et al. 1978). Spawning occurs along almost the entire shoreline area from Point Lookout (44°03', 83°35') to past Hat Point (at 44°00', 83°05'), at depths of 6 ft or less. Substrate in this area is varied and consists of sand, mud, clay, gravel, and vegetation. The rock and gravel shallows around Charity (44°02', 83°26') and Little Charity (44°00', 83°28') islands were spawning grounds. Spawning sites identified most frequently were the area from Point Au Gres (43°59', 83°41') to Saganing Bar (43°55', 83°51'), including Wigwam Bay (43°59', 83°50'), and the area from Fish Point (43°43', 83°31') to Sand Point (43°55', 83°24'). The entire bay probably serves as a nursery area. In 1975, larvae in moderate numbers were collected in mid-July off Point Au Gres, mostly at the surface over the 18 ft contour (O'Gorman 1978). Spawning was observed in the Saginaw River (43°39', 83°51') about 1 mi upstream from the mouth in May-June. Gravid females were still present at the end of June, a few were still ripe in late July, and fry were abundant in late July (Beak Consult. 1976).

Ontario

OH-3

Stokes River (45°00', 81°22'). In 1977, spawning was observed at the river mouth in late May (Loftus 1977).

Oliphant (44°44', 81°17'). In 1977, spawning was observed at Oliphant in late May (Loftus 1977).

OH-4

Maitland River (43°45', 81°44'). Carp spawn in the river at Goderich (43°45', 81°43'); these fish are probably moving in from Lake Huron (Moccia, pers. comm. 1979).

GB-4

Twelve Mile Bay (45°06', 80°04'). Shallow, weedy areas at the head of the bay are historical spawning areas (Down, pers. comm. 1979).

Matchedash Sound (44°50', 79°50'). Shallow, weedy areas near Waubashene (44°45', 79°43') are historical spawning areas (Down, pers. comm. 1979). Thousands of carp were present in the rice beds in the North (44°44', 79°39') and Coldwater (44°44', 79°39') rivers in late May (Ont. Game Fish 1912). In late May 1977, spawning was observed in the shallows around Beausoleil Island (44°51', 79°52'), and eggs were collected at Bergie Point (44°45', 79°47'). A few larvae were found at Tanner Point (44°45', 79°44'), Matchedash Bay (44°46', 79°42'), Papoose Bay (44°51', 79°52'), Tiffin Basin (44°45', 79°51'), and Penetang Harbor (44°47', 79°56') beginning on May 24 (Loftus 1977).

EMERALD SHINER

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Larvae were collected at Quanicasse (43°35', 83°40') in May-July; 25% of these were prolarvae and 6% were postlarvae (Tex. Instrum. 1979b,e).

MH-6

Port Sanilac (43°26', 82°32'). Adults concentrated directly off Port Sanilac during the spawning season, but these concentrations have not occurred in recent years (Organ et al. 1978).

Ontario

GB-4

Matchedash Sound (44°50', 79°50'). In 1977, emerald shiner larvae were collected mainly at Bergie Point (44°45', 79°47'), Tanner Point (44°45', 79°44'), and Matchedash Bay (44°46', 79°42'); the larvae first appeared in early June and were more abundant than larvae of other species (Loftus 1977).

SPOTTAIL SHINER

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). In 1974, a few spottail shiner larvae were collected off Point Au Gres (43°59', 83°41') on July 12 (O'Gorman 1976). In 1975-76, spawning probably occurred in the vicinity of the Karn-Weadock Power Plant Complex (43°39', 83°51'). Large numbers of mature adults appeared by late April and ripe adults were numerous by mid-May in Saginaw Bay. Fry were first taken in late June and by late July were abundant in the inshore waters of the bay (Beak 1976). At Quanicasse (43°35', 83°40'), spottail shiner postlarvae were 94% of the catch in June. The extensive shallow areas with sand substrate are conducive to spawning (Tex. Instrum. 1979e).

Ontario

OH-1

South Bay (45°38', 81°52'). During 1965-69, young-of-the-year spottails were found in the shallowest and warmest waters in South Bay. Adults moved out to depths of about 19-46 ft after spawning (Reckahn 1970).

LONGNOSE DACE

Michigan

MH-1

Carp (Black Mallard) Creek (45°32', 84°07') and Ocqueoc River (45°29', 84°04'). In the late 1940s, spawning runs of longnose dace entered these streams; peak upstream movement occurred from mid-April to mid- or late May, usually prior to the runs of the white sucker and sea lamprey (Applegate 1950).

QUILLBACK

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Since 1943, quillback have spawned along the east shore of the bay (Organ et al. 1978).

Fish Point (43°43', 83°31'). Spawning occurs along the outer side, south for 2-3 mi over mud and rock.

Fish Point (43°43', 83°31')--Sebewaing (43°44', 83°27'). Spawning occurs over substrate of mud, sand, and clay.

Sebewaing (43°44', 83°27'). Spawning occurs in the marshy area (43°45', 83°28') just north of the mouth of the Sebewaing River delta over mud and in a larger area (43°46', 83°29') about 2 mi farther north over mud and sand.

LONGNOSE SUCKER

Michigan

MH-1

Hammond Bay (45°30', 84°05'). Spawning activity was observed in May 1978 in the shallows along the seawall at the Hammond Bay Biological Station (45°30', 84°02'). A spawning run enters the Ocqueoc River (45°29', 84°04') between the two parts of a biphasic run of white suckers. Runs also occur in many other small tributaries in the area (Hunn, pers. comm. 1979).

Trout River (45°26', 83°50'). A large spawning run enters this river (Hunn, pers. comm. 1979).

Swan River (45°24', 83°44'). A spawning run enters this river (Hunn, pers. comm. 1980).

MH-2

Devils River (44°55', 83°25'). A large spawning run enters this river every spring (Stedman, pers. comm. 1979).

MH-4

Rifle River (44°00', 83°45'). There is a commerical fishery for longnose suckers in this river during the spawning run (Stedman, pers. comm. 1979).

Ontario

OH-1

Manitou River (45°36', 82°06') and Blue Jay Creek (45°35', 82°05'). CDFO sea lamprey weirs at the mouths of these tributaries captured a "number of tons" of longnose suckers in late April-early June 1968 (Zimmerman 1968).

OH-4

Bayfield River (43°34', 81°43'). Longnose suckers were captured at CDFO sea lamprey weirs here (FWS 1979c).

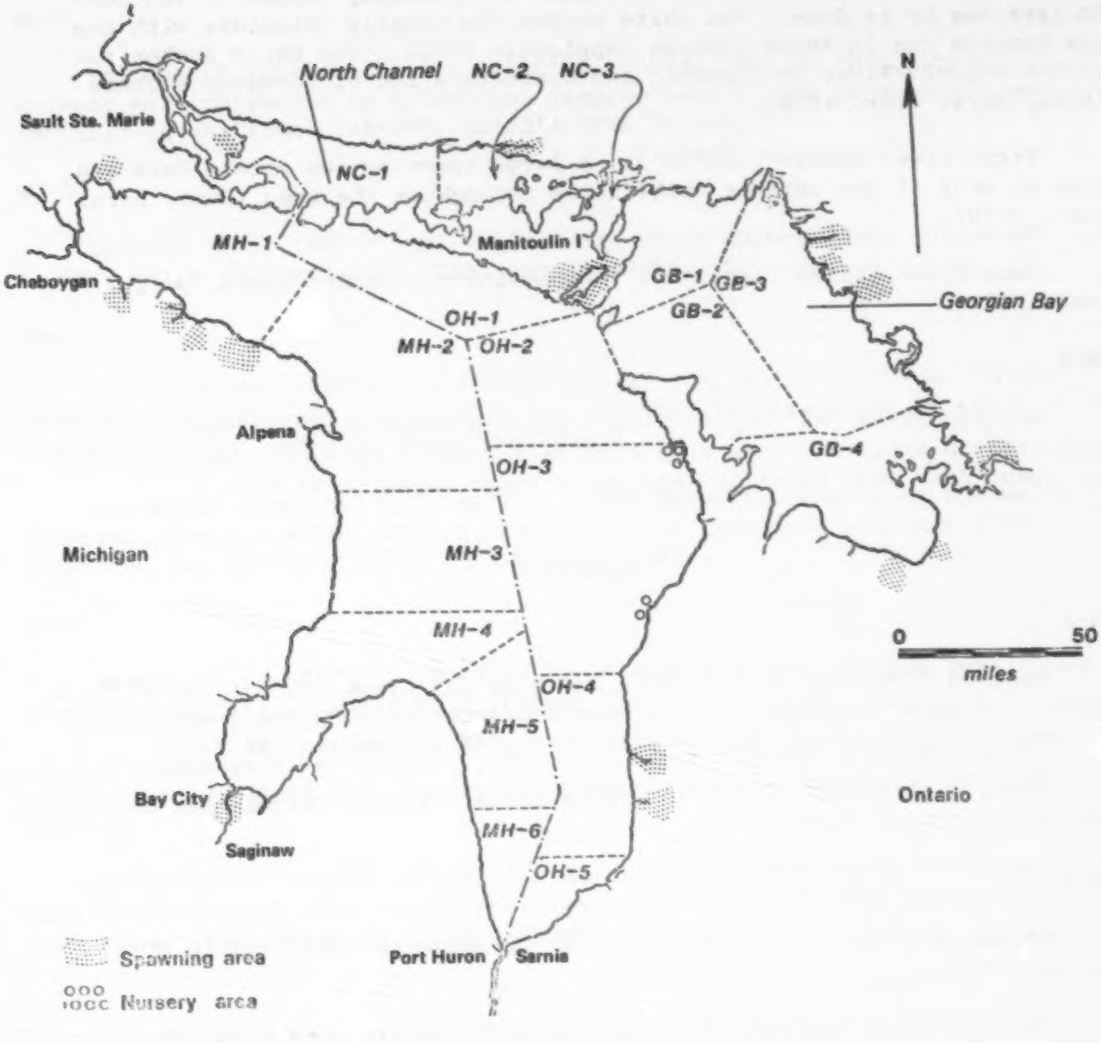
NC-1

St. Joseph Island (46°13', 84°00'). Large numbers of longnose suckers were collected in the sea lamprey weir in the Kaskawong River (Milford Haven Creek) (46°09', 83°50') (FWS 1979c).

GB-4

Nottawasaga River (44°33', 80°00'). Longnose suckers were captured at CDFO sea lamprey weirs here (FWS 1979c).

WHITE SUCKER


North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
MH-1
Manitoulin I
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
OH-3
GB-4
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Bay City
Ontario
Saginaw
MH-6
OH-5
Spawning area
Port Huron
Sarnia
Nursery area

Michigan

MH-1

Nunns Creek (46°02', 84°34'). Many spawning adults were observed here (GLFC 1972).

Cheboygan River (45°39', 84°28'). Adults spawn in the river in late April and early May, and large schools of larvae were observed in early June about 0.4 mi upstream from the mouth (O'Gorman 1979).

Carp (Black Mallard) Creek (45°32', 84°07') and Ocqueoc River (45°29', 84°04'). Large spawning runs enter these streams in May, peaking at water temperatures above 49°F. Spent fish usually return to the lake in late May or in June. The white sucker run usually coincides with the sea lamprey run in these streams (Applegate 1950). The white sucker run in the Ocqueoc River is biphasic and brackets a run of longnose suckers (Hunn, pers. comm. 1979).

Trout River (45°26', 83°50'). A large spawning run occurs here and also in many of the smaller tributaries throughout the area (Hunn, pers. comm. 1979).

Swan River (45°24', 83°44'). A spawning run occurs (Hunn, pers. comm. 1980).

MH-4

Saginaw River (43°39', 83°51'). Large numbers of adults were collected in April and May; ripe fish were present in March, and both ripe and spent fish were taken in late April (Beak Consult. 1976).

Ontario

OH-1

Manitou River (45°36', 82°06') and Blue Jay Creek (45°35', 82°05'). A "number of tons" of white suckers were collected at CDFO sea lamprey weirs in these streams in late April-early June 1968 (Zimmerman 1968).

South Bay (45°38', 81°52'). White suckers ascend tributaries here in the spring (Coble 1967).

OH-3

Stokes Bay (44°59', 81°23'). A few larvae were collected in 1977 (Loftus 1977).

Douglas Point (44°19', 81°36'). In 1975, larvae were found at the Douglas Point Generating Station in late April through early June (Kelso and Leslie 1979).

OH-4

Maitland River (43°45', 81°44'). Runs enter the river in the spring at ice breakup (Moccia, pers. comm. 1979).

Bayfield River (43°34', 81°43'). Large numbers were collected at the CDFO sea lamprey weir in the late 1960s and in the 1970s (Dahl and McDonald 1980; FWS 1979c).

In Georgian Bay (45°30', 81°00'), white suckers ascend rivers, often to the foot of the first waterfall, in early spring (Bensley 1915).

NC-1

St. Joseph Island (46°13', 84°00'). During 1967 to 1977, white suckers were collected in a CDFO sea lamprey weir in the Kaskawong River (Milford Haven Creek) (46°09', 83°50') (FWS 1979c).

NC-2

Spanish River (46°11', 82°19'). Many white suckers were collected in CDFO weirs in April-July (Dahl and McDonald 1980).

GB-3

Still (45°46', 80°34') and Naiscoot (45°40', 80°34') Rivers. Large numbers of adults were captured at the CDFO sea lamprey weirs in these rivers (Dahl and McDonald 1980; FWS 1979c).

Shawanaga River (45°32', 80°23'). The Shawanaga rapids is the major spawning site for white suckers from the river basin and possibly from Shawanaga Bay (45°30', 80°25') (Zimmerman 1967).

GB-4

Severn River (44°53', 79°42'). Dead eggs and egg capsules were found in early May 1977 at about 55°F (Loftus 1977).

Nottawasaga River (44°33', 80°00'). Large numbers of adults were captured at the CDFO sea lamprey weirs here (Dahl and McDonald 1980; FWS 1979c).

Silver Creek (44°31', 80°17'). In the late 1950s, large spawning runs were observed here in mid-April to mid-June; these fish moved back downstream after spawning (Lamsa 1963b).

SUCKER spp.

Michigan

MH-2

Thunder Bay River (45°04', 83°26'). A spawning run occurs here (Ann Arbor News 1979b).

MH-4

Saginaw Bay (44°00', 83°30'). Commercial fishermen have identified spawning grounds along almost all but the southern shoreline of the bay;

spawning occurs over substrate combinations of sand, clay, gravel, rock, and mud at depths of 3-17 ft (Organ et al. 1978).

Tawas Point (44°15', 83°27')--Point Lookout (44°03', 83°35'). Since 1915, suckers have spawned along shore in this area (Organ et al. 1978).

Point Au Gres (43°59', 83°41')--Pinconning Bar (43°51', 83°52'). Since 1928, suckers have spawned here; the area between Point Au Gres and Saganing Bar (43°55', 83°51') is heavily used (Organ et al. 1978). A massive spawning run enters the Rifle River (44°00', 83°45') in April just as the ice goes out (Ann Arbor News 1979b, 1980b; Griffin 1980; UPI 1979).

Fish Point (43°43', 83°32')--Sand Point (43°55', 83°24'). Since 1915, this area has been heavily used for spawning out to a depth of about 6 ft. Spawning also occurs west of Fish Point at depths of 12-16 ft.

Sand Point (43°55', 83°24')--east of Hat Point (44°00', 83°05') (Organ et al. 1978).

Ontario

OH-3

Saugeen River (44°30', 81°23'). Large spring runs of suckers and "mullet" entered the river (Kerr and Kerr 1860-1898).

GB-4

Sturgeon River (44°44', 79°44'). In 1970, suckers were abundant on the spawning beds in the river after April 30 (Thede 1970), and these may have been migrants from the lake.

GOLDEN REDHORSE

Michigan

MH-1

Ocqueoc River (45°29', 84°04'). One of the principal golden redhorse spawning runs from Lake Huron enters this stream. In 1949, many spawning run fish were captured at the FWS sea lamprey weir on the Ocqueoc River. Migrations occurred between late April and mid-May, before the peak of the sea lamprey run. Spent fish returned to the lake in May-July (Applegate 1950).

Carp (Black Mallard) Creek (45°32', 84°07'). In 1947 and 1948 spawning runs occurred in this stream in April and May (Applegate 1950).

REDHORSE spp.

Ontario

OH-4

Maitland River (43°35', 81°44'). Runs entered the river in the spring at ice breakup (Moccia, pers. comm. 1979).

CASTOSTOMID spp.

Michigan

MH-4

Point Au Gres (43°59', 83°41'). In 1975, catostomid larvae were collected off Point Au Gres in late May and mid-July (O'Gorman 1978).

BLACK BULLHEAD

Michigan

MH-2

Thunder Bay (45°00', 83°20'). Black bullheads are caught in Squaw Bay (45°00', 83°27') and probably spawn there (Stedman, pers. comm. 1979).

YELLOW BULLHEAD

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Spawning probably occurred in the vicinity of the Karn-Weadock Power Plant Complex (43°39', 83°51') in Saginaw Bay, where gravid females were found until late June and spent females were found in late July-early August (Beak Consult. 1976).

BROWN BULLHEAD

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Spawning has occurred since 1959 between Fish Point (43°43', 83°31') and Sebewaing (43°44', 83°27') in a marshy area where the substrate is mud, sand, and rock. Another small spawning area exists in the marsh about 1 mi N of Sebewaing (Organ et al. 1978).

Ontario

In Georgian Bay (45°30', 81°00'), brown bullheads spawn from late June to early July; nests are built in shallow water 2-3 ft from shore (Bensley 1915).

CHANNEL CATFISH

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Channel catfish spawn in a number of areas in the bay (Organ et al. 1978, unless noted).

> Charity Island (44°02', 83°26'). Since 1962, spawning has occurred in a sand and gravel, crescent-shaped area around the north side of the island at a depth of about 6 ft.
>
> Point Lookout (44°03', 83°35')--Nayanquing Point (43°46', 83°56'). Spawning occurs in this entire area to depths of 18-24 ft; the substrate here is sand, mud, and clay. The earliest reported catch of spawners was 1928.
>
> Tobico Marsh (43°42', 83°56'). Channel catfish spawn to depths of 6-8 ft from the south end of the marsh to the mouth of the Kawkawlin River (43°40', 83°53'); the substrate here is mud and clay.
>
> Saginaw River (43°39', 83°51')--Quanicasse (43°35', 83°41'). Spawning occurs in the shallow areas with mud and sand bottom extending for about 6 mi E of the Saginaw River. Large numbers of fry were collected in the discharge of the Karn-Weadock Power Plant Complex (43°39', 83°51') in June-September; they may inhabit crevices in the diking (Beak Consult. 1976).

Squaw Creek (43°37', 83°38')--Fish Point (43°43', 83°31'). A spawning area (43°40', 83°40'--43°45', 83°35') extends from about 3-5 mi N of the mouth of Squaw Creek at depths of 12-14 ft (Organ et al. 1978).

Fish Point (43°43', 83°31')--Sand Point (43°55', 83°24'). Since 1915, spawning has occurred throughout this shallow, mud-bottomed area to a depth of about 6 ft. Spawning also occurs northwest of North Island (43°53', 83°25') at 43°54', 83°27' at depths of 12-14 ft; the substrate here is sand.

Sand Point (43°55', 83°24'). Spawning occurs off the north side of the point over sand and gravel to 12 ft depths.

BULLHEAD spp.

Michigan

MH-4

Point Au Gres (43°59', 83°41')--Nayanquing Point (43°46', 83°56'). Spawning occurs along this shore to a depth of about 24 ft, where the substrate is sand with clay, rock, and mud; earliest reported spawning here was in 1928 (Organ et al. 1978).

Fish Point (43°43', 83°31')--Sand Point (43°55', 83°24'). Since 1927, spawning has occurred along this shore where the substrate is mud (Organ et al. 1978).

TROUT-PERCH

Michigan

MH-2

Rockport (45°12', 83°23'). Trout-perch postlarvae were collected in July; they were less than 1% of the total (Tex. Instrum. 1979c).

MH-4

Alabaster (44°11', 83°33'). Trout-perch postlarvae were found in June; they were less than 1% of the total larval catch (Tex. Instrum. 1979d).

Saginaw River (43°39', 83°51'). Trout-perch were abundant in the vicinity of the Karn-Weadock Power Plant Complex (43°39', 83°51') only in late April and May; large numbers of sexually mature adults moved inshore to spawn at that time and larvae were also collected (Beak Consult. 1976).

Ontario

OH-1

South Bay (45°38', 81°52'). Spawning aggregations occurred in shallow water in June and early July; these fish moved into the metalimnion in July and August. Young-of-the-year were found in shallow, warm waters in July and August (Faber 1970).

BURBOT

Michigan

MH-1

St. Vital Point (45°57', 84°00'). In 1975, a few larvae were captured off the point in June (O'Gorman 1978).

MH-2

Rockport (45°12', 83°23'). Postlarvae were collected in June; they were less than 1% of the total postlarvae taken (Tex. Instrum. 1979c).

Thunder Bay (45°00', 83°20'). In 1975, small numbers of larvae were collected off Alpena (45°04', 83°26') in May (O'Gorman 1978).

MH-4

Saginaw Bay (44°00', 83°30'). Significant spawning has not occurred in the bay since the 1940s, but occasional spawning still occurs along shore in the outer bay and outer portion of the inner bay; spawning occurs to depths of 24-30 ft in February. Areas where spawning has occurred most recently are on the west shore from Tawas Point (44°15', 83°27') to Point Lookout (44°03', 83°35'), Point Au Gres (43°59', 83°41') to Saganing Bar (43°55', 83°51'), and on the east shore from Sand Point (43°55', 83°24') to east of Hat Point (at 44°00', 83°05') (Organ et al. 1978). On May 30, 1975, one burbot larva was collected near Port Austin (44°03', 83°00') and another was collected near Point Au Gres (O'Gorman 1978). In 1979, burbot larvae were collected in April and May off Alabaster (44°11', 83°33'), but they were less than 1% of the total prolarvae and less than 1% of the post larvae taken (Tex. Instrum. 1979d).

MH-5

Harbor Beach (43°51', 82°39'). A few larvae were collected over rocks and boulders (LaJeone, pers. comm. 1979).

Ontario

OH-1

South Bay (45°38', 81°52'). Spawning occurs regularly along parts of the South Bay shoreline shortly after ice breakup (Faber 1970). Larvae only a few hours old were found along shore in early June 1964 and in April and May 1965-1968 (Faber 1964, 1970). Larvae were also collected in 1977 (Loftus 1977). Older larvae disperse throughout surface waters over deeper waters (Faber 1970).

BROOK STICKLEBACK

Ontario

OH-3

Douglas Point (44°19', 81°36'). In 1975, larvae were collected here in moderate numbers in mid to late July (Kelso and Leslie 1979).

NINESPINE STICKLEBACK

Michigan

MH-1

Nagels Creek (45°27', 83°52'). Ninespine sticklebacks run upstream in the spring to spawn in Nagel's Creek at Rogers City (45°25', 83°49') (Stedman, pers. comm. 1979).

MH-2

Rockport (45°12', 83°23'). In July 1978-79, prolarvae and postlarvae of this species each made up 5% of the larval catch (Tex. Instrum. 1979c).

Ontario

OH-1

South Bay (45°38', 81°52'). During spawning in June and July, adults were abundant in shallow vegetated areas of the bay (Reckahn 1970). During May-July 1967, when water temperatures were about 49-62°F, nesting activity was observed along the southeast shore of the bay and also along the rocky base of the access road leading to the wharf of the research station, near the northwest side of the mouth of the bay. In the latter area, nests were built under or between rocks, about 1-5 ft from shore at water depths of about 1-3 ft. Successful nests were located in quiet areas on the leeward side. The area supported no rooted vegetation, but the nests contained algae picked off the rocks. Along the southeast shore in less sheltered waters, nests were found along a rocky shelf in sand, under and among rocks. Newly hatched fry were guarded by the male parent. Older fry were scattered and hidden among the rocks (McKenzie and Keenleyside 1969).

WHITE BASS

Michigan

MH-4

Saginaw River (43°39', 83°51'). Mature adults were collected in the river and Saginaw Bay (44°00', 83°30') in the vicinity of the Karn-Weadock Power Plant Complex (43°39', 83°51') in late April-late May, spent adults by late June, and fry by late July (Beak Consult. 1976).

Ontario

GB-4

Matchedash Sound (44°50', 79°50'). A few larvae were collected in the inner portions of the sound at Tanner Point (44°45', 79°44') and Matchedash Bay (44°46', 79°42') beginning in late May (Loftus 1977).

ROCK BASS

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). The only recorded rock bass spawning grounds in the U.S. waters are in Saginaw Bay (Organ et al. 1978).

Wigwam Bay (43°59', 83°50')--Pinconning Bar (43°51', 83°52'). Spawning occurred along shore over sand and rock.

Fish Point (43°43', 83°31')--Sebewaing (43°44', 83°27'). Spawning occurred here over mud and clay.

Ontario

OH-1

South Bay (45°38', 81°52'). In the late 1960s, young-of-the-year (YOY) were collected in the warmest and shallowest areas of the bay during July and August (Reckahn 1970).

OH-3

Baie du Dore (44°21', 81°34'). The southeast corner of the bay is an important spawning and nursery area. Nest building was observed over sand, gravel, and plant roots at depths of about 1-5 ft from early June to early July at about 57-71°F. Fry and older YOY remained in the sheltered areas of the bay among dense Myriophyllum through their first summer (Griffiths 1976b, 1978b). Nest building and guarding was also seen in the discharge canal of the Bruce Generating Station (44°19', 81°36') in June and July (Dunford 1978b).

In Georgian Bay, rock bass spawn nearshore in June (Bensley 1915).

GB-3

Pointe au Baril (45°34', 80°30'). Nesting was observed during the 1920s among the small islands (45°29', 80°29') about 5 mi S of the point among rock covered with muck and vegetation at water temperatures of 65-75°F (Hubbs and Brown 1929).

PUMPKINSEED

Michigan

MH-4

Sand Point (43°55', 83°24'). In 1908, spawning was observed in early July in Turtle Bay (43°54', 83°20'), a partially enclosed embayment on the south side of Sand Point. Females with nearly ripe eggs were found as early as June 23, and ripe males were seen as late as August 20. The nests were in 0.5-3 ft of water and were cleared of sediment and plant material to expose the plant roots or coarse gravel (Leathers 1911).

Saginaw River (43°39', 83°51'). Spent adults were collected at the Karn-Weadock Power Plant Complex (43°39', 83°51') in late July-early August. Fry first appeared in late September and were abundant about 1 mi above the river mouth (Beak Consult. 1976).

Ontario

OH-3

Baie du Dore (44°21', 81°34'). The southeast corner of the bay is an important spawning and nursery area, and the young remain in the sheltered areas of the bay through their first summer of life (Griffiths 1978b).

OH-5

Plympton Conservation Area (43°04', 82°10'). Spawning occurs here (Environ. Can. 1977c).

In Georgian Bay, spawning usually occurs in July (Bensley 1915).

GB-4

Matchedash Sound (44°50', 79°50'). Larvae were collected throughout the sound. Hatching began the last week of May, and a second peak occurred the last week of June (Loftus 1977).

BLUEGILL

Ontario

OH-5

Plympton Conservation Area (43°04', 82°10'). Spawning occurs here (Environ. Can. 1977c).

SUNFISH spp.

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Commercial fishermen reported spawning by unidentified sunfish in several area of the bay (Organ et al. 1978).

Wigwam Bay (43°59', 83°50')--Saganing Bar (43°55', 83°51'). Spawning occurs here over sand, clay, and vegetation to depths of 10-12 ft.

Gilman's Landing (43°48', 83°55')--Saginaw River (43°39',83°51'). Since the 1930s, spawning occurred here over sand and gravel to a depth of about 20 ft.

Saginaw River (43°39', 83°51')--Quanicasse River (43°35', 83°41'). Since the 1930s, spawning occurred here over sand and gravel to a depth of about 12 ft.

Fish Point (43°43', 83°31')--Sand Point (43°55', 83°24'). Since 1938, spawning has occurred in this entire area over a mud bottom. Since 1959, spawning has occurred on the outside of Fish Point.

Ontario

OH-1

South Bay (45°38', 81°52'). In 1964, one larva was collected here in mid-August (Faber 1964).

SMALLMOUTH BASS

Michigan

MH-1

Cheboygan River (45°39', 84°28'). In 1929-33, a few smallmouth bass were collected during spawning migrations from the lake; these runs were blocked by the dam near the mouth of the river (Shetter 1937).

Ocqueoc River (45°29', 84°04'). Larvae and young-of-the-year (YOY) have been found in the lower river; this is a nursery area. A spawning run from the lake probably occurs (King, pers. comm. 1980).

MH-2

Thunder Bay (45°00', 83°20'). The area from Sulphur Island (44°59', 83°25') to South Point (44°53', 83°19') is excellent smallmouth bass habitat; the substrate is rubble with patches of vegetation and is a potential spawning area (Stedman, pers. comm. 1979).

MH-4

Saginaw Bay (44°00', 83°30'). Most spawning areas identified in the U.S. waters of Lake Huron are in Saginaw Bay (Organ et al. 1978).

Charity Islands (44°01', 83°27'). Since 1927, spawning has occurred around Charity (44°02', 83°26') and Little Charity (44°00', 83°28') islands over rock, gravel, and sand area.

Wigwam Bay (43°59', 83°50')--Pinconning Bar (43°51', 83°52'). Spawning occurs in Wigwam Bay over clay and sand to depths of 6 ft and from Wigwam Bay to Saganing Bar (43°55', 83°51') over sand and vegetation to depths of 10-12 ft. Localized spawning also occurs about 1 mi E of Wigwam Bay (at 44°00', 83°44') over mud.

Fish Point (43°43', 83°31')--Sand Point (43°55', 83°24'). Since 1927, spawning has occurred in this entire area over mud with clay and sand.

Ontario

OH-1

South Bay (45°38', 81°52'). In the late 1960s, YOY were collected here in the warmest and shallowest areas during July and August (Reckahn 1970). The population in the bay is believed to be relatively discrete from those in the main lake. Most of the population is concentrated in the northeast part of South Bay. In South Bay, a spawning migration may occur from Jocko (Roberts) Bay (45°35', 81°54') to the Inner Basin (45°37', 81°54') (Fraser 1955).

OH-3

Baie du Dore (44°21', 81°34'). The southeast corner of the bay is a major smallmouth bass spawning area. Young-of-the-year remain in the sheltered areas of the bay throughout their first summer (Griffiths 1978b). Spawning begins in the bay when water temperature rises above 59°F. Most nests are built at about 51-70°F, and activity decreases in late June (Shuter et al. 1980). Nest building and guarding has also been observed during mid-June to late July in the inner discharge canal of the Bruce Generating Station (44°19', 81°36') (Dunford 1978b).

In Georgian Bay, adults move inshore in late May and usually spawn in June; nesting was observed as late as July 20 (Bensley 1915).

GB-1

Spawning evidently occurred along the north shore of Georgian Bay, because it was recommended that this area be closed to fishing (Ont. Game Fish 1931).

GB-3

Pointe au Baril (45°34', 80°30'). In 1936, nests were observed here on a gravel substrate in 18 in. of water in late June to mid-July. Most of the nests were built on the sheltered sides of islands (Doan 1938b, 1940). Fry were also observed in the nests (Doan 1938b).

GB-4

Go Home Bay (44°59', 79°57'). Nests were built in late June among small stones in 3-4 ft of water, in protected areas near boulders, rock ledges, or fallen trees; the eggs adhered to the stones (Tester 1930).

LARGEMOUTH BASS

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). The only spawning areas identified in the U.S. waters of Lake Huron are in Saginaw Bay (Organ et al. 1978).

Charity Islands (44°01', 83°27'). Since 1927, spawning has occurred around Charity (44°02', 83°26') and Little Charity (44°00', 83°28') islands over rock and gravel.

Wigwam Bay (43°59', 83°50')--Pinconning Bar (43°51', 83°52'). Spawning occurs in Wigwam Bay over clay and sand to depths of 6 ft; from Wigwam Bay to Saganing Bar (43°55', 83°51') over sand and vegetation to depths of 10-12 ft; and from Saganing Bar to Pinconning Bar over sand and rock in the very shallow shore zone. Localized spawning also occurs in an area (44°00', 83°44') about 1 mi E of Wigwam Bay over mud.

Nayanquing Point (43°46', 83°56'). Spawning occurs in the marshy areas over mud and vegetation.

Tobico Marsh (43°42', 83°56'). Spawning may occur from the south end of Tobico Marsh to the mouth of the Kawkawlin River (43°40', 83°53') over mud and sand to depths of 6-8 ft.

Fish Point (43°43', 83°31')--Sand Point (43°55', 83°24'). Since 1927, spawning has occurred over mud, sand and vegetation throughout this entire shallow area. Spawning also occurred in an area (43°41', 83°35') along the outside edge of Fish Point over clay, rock, and mud to depths of 12 ft.

Ontario

In Georgian Bay (45°30', 81°00'), spawning occurred in early June on a bottom of soft detritus (Bensley 1915).

BASS spp.

Ontario

Unidentified species of bass spawned in the following areas in Canadian waters:

OH-5

Plympton Conservation Area (43°04', 82°10'). (Environ. Can. 1977c).

NC-3

Manitoulin Island (45°50', 82°30'). Bass had not finished spawning at Manitowaning (45°45', 81°47') by June 15 (Ont. Game Fish 1913b).

GB-3

Sandy Island (45°16', 80°16'). Spawning occurs west of Sandy Island at 45°16', 80°17' (Environ. Can. 1977c).

GB-4

Honey Harbor (44°52', 79°49'). Black bass were observed spawning along shore, and schools of young were seen along shore (Ont. Game Fish 1908, 1909).

Matchedash Bay (44°46', 79°42') and Victoria Harbor Bay (44°45', 79°47') (Environ. Can. 1977c).

Collingwood (44°30', 80°13'). Historically, bass spawned here and were netted in May as they entered two unidentified bays to spawn (Kerr and Kerr 1860-1898).

BLACK CRAPPIE

Ontario

GB-4

Matchedash Sound (44°50', 79°50'). Black crappie larvae were abundant in collections from mid-May to July; most were newly hatched. One hatching period occurred in May and another in late June (Loftus 1977).

CRAPPIE spp.

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). Commercial fishermen identified spawning areas in Saginaw Bay (Organ et al. 1978).

Wigwam Bay (43°59', 83°50')--Saganing Bar (43°55', 83°51'). Crappies spawn in this area over sand and vegetation. Localized spawning also occurs over mud in an area (44°00', 83°44') about 1 mi E of Wigwam Bay.

Nayanquing Point (43°46', 83°56'). Spawning occurs in the marshy areas over mud and vegetation.

Fish Point (43°43', 83°31')--Sand Point (43°55', 83°24'). The earliest reported catch of spawners here was in 1915. Spawning occurs throughout this area; the substrate is primarily mud with sand, clay, or vegetation. Spawning also occurs in this region and in an area extending about 3 mi S from Fish Point over sand and rock at the 6 ft contour. Since 1938, crappies have also spawned off the northwest point of North Island (43°53', 83°25') over a sand area (43°54', 83°27') at depths of 12-14 ft.

Sand Point (43°55', 83°24')--Hat Point (44°00', 83°07'). Since 1915, spawning has occurred in the area from Sand Point to Oak Point (43°38', 83°16') over sand and rock to depths of about 6 ft, around Oak Point over rock and gravel to depths of about 24 ft, and from Oak Point to just east of Hat Point (44°01', 83°05') over rock, sand, and gravel to depths of about 24 ft.

JOHNNY DARTER

Michigan

MH-2

Rockport (45°12', 83°23'). In 1978-79, prolarvae of this species were collected in April-July; they were 1% of the total catch of prolarvae (Tex. Instrum. 1979c).

MH-4

Alabaster (44°11', 83°33'). In 1979, prolarvae were found in June and July; they were 1% of the total catch of prolarvae (Tex. Instrum. 1979d).

Ontario

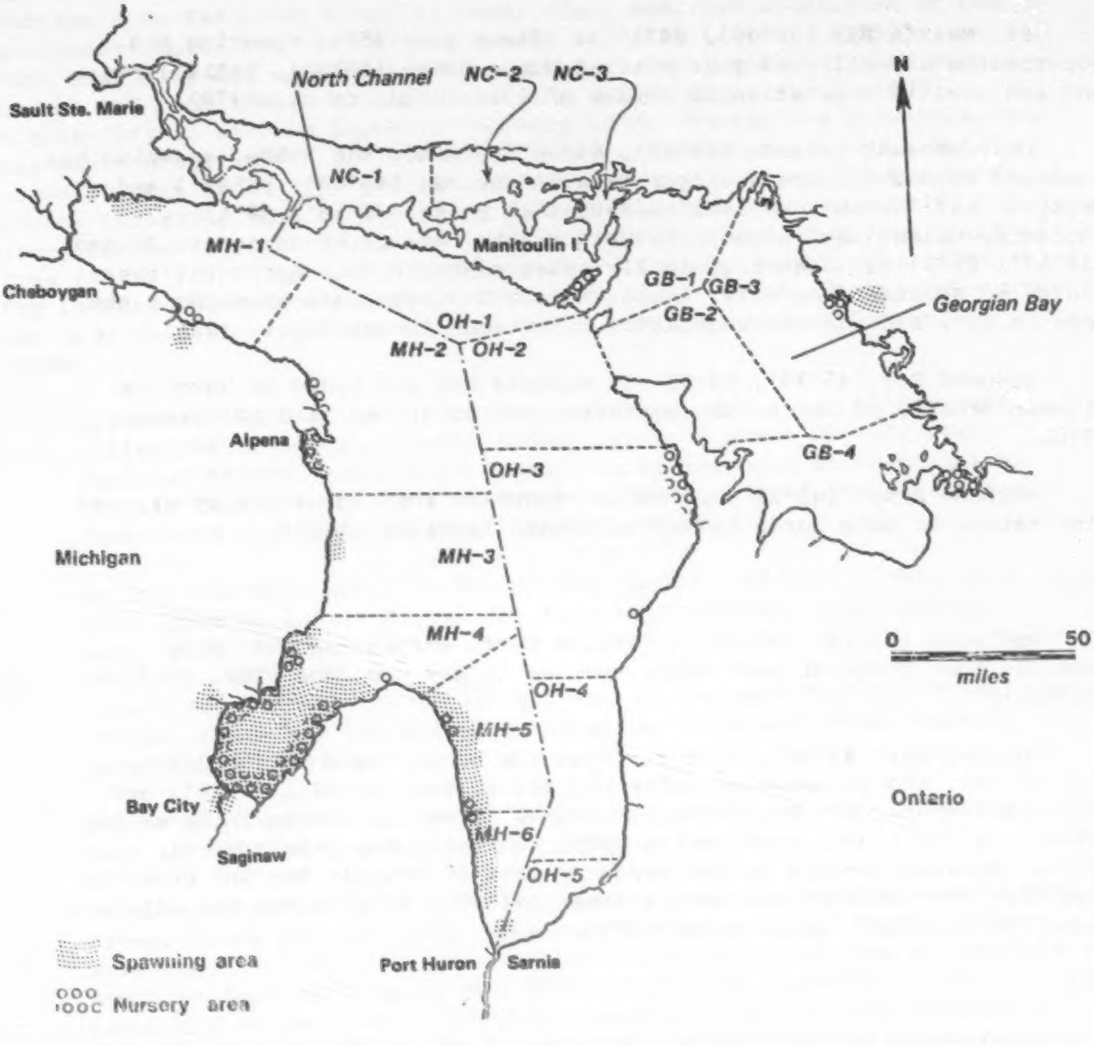
OH-3

Douglas Point (44°19', 81°36'). Larvae of this species were entrained at the Bruce Generating Station; they were 1.5% of the total catch of larvae (Dunstall 1978a).

GB-4

Matchedash Sound (44°50', 79°50'). In 1977, larvae were collected throughout the bay (Loftus 1977).

YELLOW PERCH


North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
MH-1
Manitoulin I
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
OH-3
GB-4
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Bay City
Ontario
MH-6
Saginaw
OH-5
Spawning area
Nursery area
Port Huron
Sarnia

The shallow bays of Lake Huron contain preferred spawning grounds for yellow perch. The bays and irregular stretches of the coastline serve as nursery areas. In the northern part of Lake Huron, spawning does not occur until early summer, usually late May or early June (O'Gorman 1975, 1976, 1978, 1979).

Michigan

MH-1

St. Martin Bay (46°00', 84°37'). Since the 1950s, spawning has occurred in a small area just west of Nunns Creek (46°02', 84°34') over mud and aquatic vegetation to depths of 6 ft (Organ et al. 1978).

Les Cheneaux Islands (45°58', 84°20'). Since the 1950s, spawning has occurred throughout the shallows from Mismer Bay (46°00', 84°27') and Mackinac Bay (46°00', 84°24') to Whitefish Point (45°58', 84°13'), including Voight Bay (45°56', 84°23') on the outside of Marquette Island (45°57', 84°23'). Spawning usually takes place in late April but the timing is dependent on water temperature. The substrate throughout the area is mud, and aquatic vegetation is present (Organ et al. 1978).

Hammond Bay (45°30', 84°05'). Hammond Bay was found to have the highest density of fry in the northern section of the lake (O'Gorman 1978).

Ocqueoc River (45°29', 84°04'). Spawning runs enter the river, and fish return to Lake Huron in May and June (Applegate 1950).

MH-2

Rockport (45°12', 83°23'). Yellow perch postlarvae were more numerous than those of most other species in May and June (Tex. Instrum. 1979b,c).

Thunder Bay (45°00', 83°20). Spawning occurs here in the latter part of May, and larvae were collected off Alpena (45°04', 83°26') and Ossineke (44°55', 83°25') (O'Gorman 1978). Spawning occurs in Squaw Bay (45°00', 83°27') over sand during April and early May (Organ et al. 1978). Spawning occurs in the northern part of Thunder Bay and probably also near the mouth of the Devils River (44°55', 83°25') and the adjacent shoreline (Stedman, pers. comm. 1979).

MH-3

Harrisville (44°40', 83°18'). Spawning occurs off Harrisville over sand to depths of about 19 ft and just south of the Harrisville State Park (44°38', 83°18') during April and early May (Organ et al. 1978).

MH-4

Saginaw Bay (44°00', 83°30'). Historically, this was an important spawning area. Egg masses were found in the bay in the early 1900s (Reighard 1915), and spawning runs were noted in 1929 and 1930 (Hile and Jobes 1940). Runs into the bay may begin in mid-April (UPI 1979). Commercial fishermen captured spawning yellow perch in April and May in almost all areas of the bay at depths of 30 ft or less; the first reported catch was in 1915 (Organ et al. 1978). Spawning areas include almost all areas of the bay at depths of 30 ft or less; the first reported catch was in 1915 (Organ et al. 1978). Spawning areas include the entire rock and

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gravel shoreline of the outer basin (44°10', 83°20'), the waters around Charity Island (44°02', 83°26'), and all parts of the inner basin (43°50', 83°40') except the small central portion, which is deeper than 30 ft. Substrate in the inner basin is sand, clay, mud, and vegetation on the northwest shore; sand and gravel around Bay City (43°36', 83°52'); mud with some clay and sand along the southeast shore; and sand with some gravel and rock toward the middle of the basin (Organ et al. 1978). Saginaw Bay is also an important nursery area. During the mid-1970s, the bay was the only place in Lake Huron where yellow perch fry were more abundant than smelt fry (O'Gorman 1978). More yellow perch fry were found in the inner bay than in any other part of the lake (O'Gorman 1975). Young-of-the-year are generally found in every cut or ditch from Point au Gres (43°59', 83°41') to the Saginaw River (Gulvas, pers. comm. 1980). Fry inhabit the inshore water at depths of 12 ft or less during the summer and move to deeper water in October (Carr 1962; O'Gorman 1975; Wells 1968).

Alabaster (44°11', 83°33'). Ripe, running, and spent adults were gillnetted in April at water temperatures of about 39-45°F (Tex. Instrum. 1979d). Yellow perch was one of the most abundant larvae here in May and June; 7% of the prolarvae and 7% of the postlarvae taken were yellow perch (Tex. Instrum. 1979b,d).

Au Gres (44°03', 83°42')--Wigwam Bay (43°59', 83°50'). This is a good spawning area. Wigwam Bay is a major nursery area (Gulvas, pers. comm. 1980),

Pine River (43°59', 83°51'). A large run entered this river (Martin 1939a), but a run has not occurred since the early 1960s (Gulvas, pers. comm. 1980).

Pinconning (43°52', 83°58'). Ripe adults and eggs were collected here in mid- to late April (MWRC 1974).

Saginaw River (43°39', 83°51'). Spawning runs evidently entered the river, where spawners were reported in February 1907 (MSBFC 1909b). More recently, egg strands were found just east and west of the river mouth in late April-early May (MWRC 1974). No spawning occurs presently in the river, but large numbers of adults move inshore to spawn west and east of the river mouth. Ripe fish are found there as early as mid-March. Spawning begins in late April, when the water temperature is 59-61°F, and is mostly completed by late May, when many spent adults are found. Eggs were found on gillnets and taken in trawls in April (Beak Consult. 1976). At the Karn-Weadock Power Plant Complex (43°39', 83°51'), the impingement of adults was highest from mid-March to mid-May. Unfertilized eggs were entrained from late April to early June; the first larvae were entrained in late May (Consumers Power 1976c,d). The first fry were captured in trawls in late June (Beak Consult. 1976). During the mid-1970s, the greatest densities of fry in the U.S. waters of Lake Huron were found off the Saginaw River mouth in late May and early June (O'Gorman 1975).

Quanicasse (43°35', 83°40'). Yellow perch were 16% of the prolarvae and 50% of the postlarvae taken. Juvenile yellow perch made up 100% of the seine catch in June. The vegetated shoreline and sand bottom here provide good spawning habitat (Tex. Instrum. 1979b,e). Ripe fish and egg strands were found on April 13-18, indicating successful spawning (MWRC 1974).

Fish Point (43°43', 83°31')--Sand Point (43°55', 83°24'). The waters between these points and Charity Island (44°02', 83°26') appear to be heavily used for spawning (El-Zarka 1959; Jaworski and Raphael 1978). Adults were collected in this region April 18-June 7, and peak spawning occurred around mid-May (El-Zarka 1959).

Port Austin (44°03', 83°00'). Moderate numbers of fry were found here (O'Gorman 1978).

MH-5

Pointe aux Barques Light (44°01', 82°48')--Richmondville (43°34', 82°36'). From 1917-1969, spawning occurred all along the shore over mud, sand, and rock to a depth of about 24 ft (Organ et al. 1978). Running-ripe adults were captured in the area from Harbor Beach (43°51', 82°39') to a location (43°55', 82°40') 5 mi N at depths to 45 ft; larvae were collected in this area in May-July, and peak abundance occurred in June (LaJeone, pers. comm. 1979; O'Gorman 1978). A few fry were collected at Richmondville in May (O'Gorman 1976, 1978).

MH-6

Richmondville (43°34', 82°36')--Burtchville Park (43°08', 82°30'). From 1917-1969, spawning occurred along shore over mud, sand, and rock to a depth of about 24 ft (Organ et al. 1978).

Port Huron (43°00', 82°26'). Yellow perch formerly spawned near the Number 2 buoy north of Port Huron, but the area was ruined by dredging (Dalton, pers. comm. 1979). At Port Huron, yellow perch generally spawned a few days later than the walleye (MSBFC 1909a).

Ontario

OH-1

South Bay (45°38', 81°52'). In 1964, early larvae were abundant in the upper bay; maximum abundance occurred in early June (Faber 1964).

OH-3

Fishing Islands (44°50', 81°22'--44°43', 81°20'). In 1977, larvae were found throughout the area. Hatching may have begun around May 5 and continued to early June. The density of larvae peaked during the second week of May. Larvae were most numerous in Pike Bay (44°52', 81°20') (8,224 per 1000 m^3) and were also numerous in Stokes Bay (44°59', 81°23').

Newly hatched larvae were found on May 10 in Howdenvale Bay (44°49', 81°18') when the water temperature was about 42°F (Loftus 1977).

Douglas Point (44°19', 81°36'). Larvae were collected here from early June to early July (Kelso and Leslie 1979).

GB-3

Shawanaga River (45°32', 80°23'). An extremely large catch of adults was made here in the spring (Zimmerman 1966, 1967). Young-of-the-year were found in comparatively high numbers in the summer along shorelines throughout the Groundhog Islands (45°32', 80°30') area (Zimmerman 1966).

GB-4

Matchedash Sound (44°50', 79°50'). In 1977, yellow perch larvae were found at all sites sampled. Hatching began in late April and continued for about one month. The highest density of larvae (35,000 per 1000 m^3) occurred at Bergie Point (44°45', 79°47') on June 13 (Loftus 1977).

CHANNEL DARTER

Michigan

MH-1

Cheboygan River (45°39', 84°28'). Channel darters migrate into the river to spawn in July at water temperatures of 69-72°F. The spawning ground, about 1 mi above the river mouth, has a substrate of rock, gravel, and sand, a swift current, and a water depth of 1-1/2 to 5 ft (Winn 1953).

SAUGER

Michigan

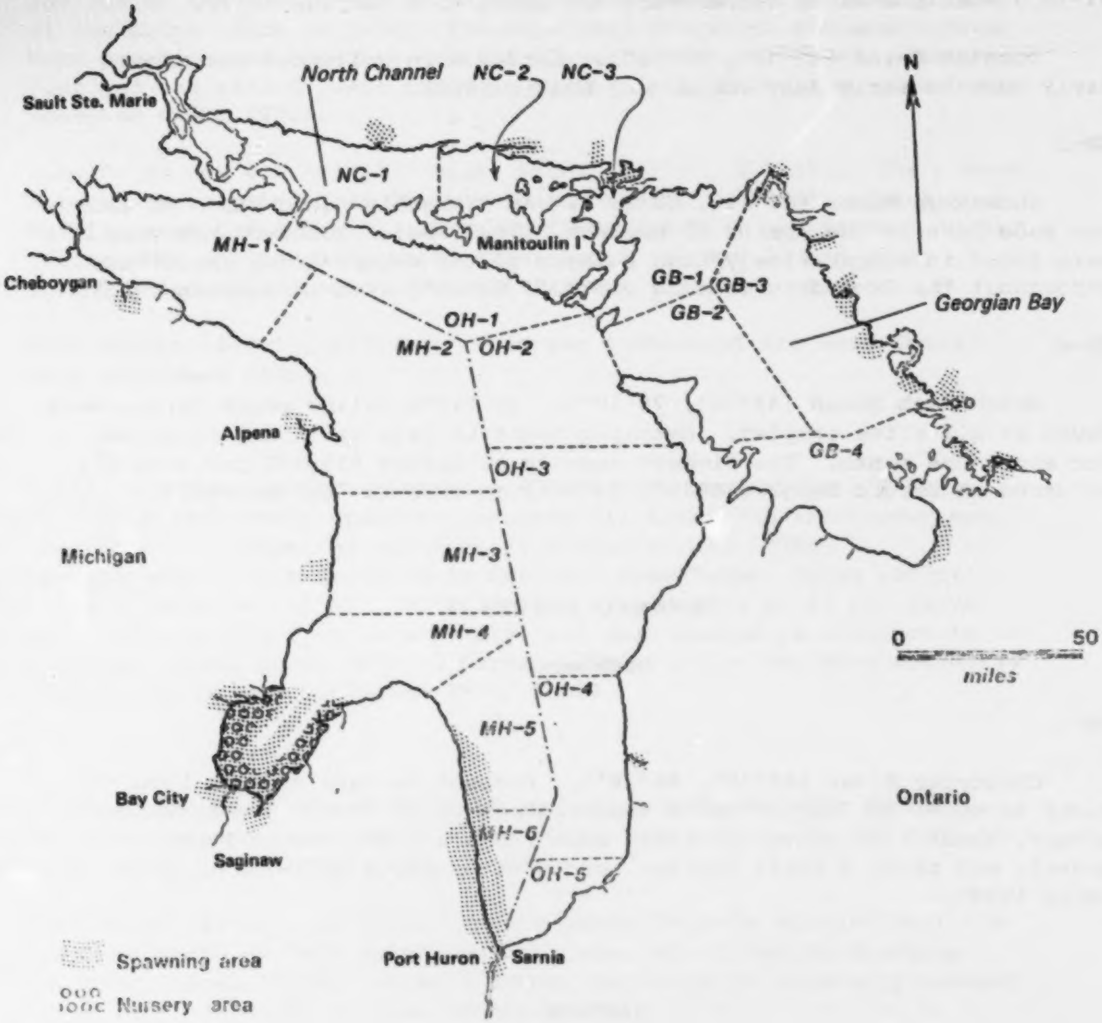
MH-2

Thunder Bay (45°00', 83°20'). In the 1880s, large numbers were caught here in the spring (MSBFC 1887).

MH-4

Saginaw Bay (44°00', 83°30'). In 1933-35, ripe fish were caught between Point Lookout (44°03', 83°35') and Point Au Gres (43°59', 83°41') over clay in 6-30 ft of water (Organ et al. 1978).

WALLEYE


North Channel
NC-2
NC-3
N
Sault Ste. Marie
NC-1
MH-1
Manitoulin I
Cheboygan
GB-1
GB-3
GB-2
Georgian Bay
OH-1
MH-2
OH-2
Alpena
GB-4
OH-3
Michigan
MH-3
MH-4
0
50
miles
OH-4
MH-5
Bay City
Ontario
MH-6
Saginaw
OH-5
Port Huron
Sarnia
Spawning area
Nursery area

Various distinct walleye stocks exist in Lake Huron. Alteration of spawning habitat was the primary cause for the decline of stocks in the lake (Schneider and Leach 1977).

Michigan

MH-1

Point De Tour (45°57', 83°55'). In the northwest part of Lake Huron, the largest concentration of walleyes occurred in the vicinity of De Tour

(Schneider and Leach 1979). These fish presumably remained in the area or migrated into the St. Marys River to spawn.

Cheboygan River (45°39', 84°28'). Substantial walleye spawning runs occurred in the river as early as the mid-1800s. The run was adversly affected by the installation of dams, which began in 1847, and by sawmills, papermills, and logging; by 1903 it was negligible (Schneider and Leach 1979). A small spawning run developed in later years. For many years, walleyes were collected at the Cheboygan Dam near the river mouth during March and April and transferred upstream (Eschmeyer 1950; Eschmeyer and Crow 1955; Schneider and Leach 1979; Shetter 1937). On April 28, 1948, viable eggs were collected below the Alverno Dam on the Black River, which is a tributary to the Cheboygan River (Eschmeyer 1950) and a major spawning area (Schneider and Leach 1974). Spawning runs occurred in the Cheboygan River during the 1970s (Schneider and Leach 1979).

Ocqueoc River (45°29', 84°04'). Walleyes in large numbers have been caught in the Ocqueoc River, but it is not known if these are stream residents or migrants from Lake Huron (FWS 1979c). Some were taken in early years in Hammond Bay (45°30', 84°05') (Schneider and Leach 1979).

MH-2

Thunder Bay River (45°04', 83°26'). Industrial and sawmill pollutants and dams are believed to have altered the spawning habitat in the Thunder Bay River, causing declines in the populations in the 1920s (Schneider and Leach 1977, 1979). A spring run of walleyes entered the Thunder Bay River in 1925 but not in the 1930s (Schneider and Leach 1979).

MH-3

Au Sable River (44°24', 83°19'). Alteration of spawning habitat caused declines in the spawning population of walleyes in the river in the late 1800s; few survived the logging and lumbering era (Schneider and Leach 1977, 1979). Before dams were built in 1911, walleyes migrated about 88 mi upstream to the mouth of the North Branch (Miller 1966, as cited in Schneider and Leach 1979).

MH-4

Saginaw Bay (44°00', 83°30'). Saginaw Bay has historically been the primary spawning area for walleyes in Lake Huron. Eggs were taken from spawning populations in the bay as early as the 1800s (Nepszy 1977) and into the early 1900s, when mature fish were taken just after ice breakup at temperatures of 35-39°F (Downing 1905; Martin 1939b; MSBFC 1888, 1895, 1890; Westerman 1928, 1930, 1933, 1934, 1937, 1940, 1942). Spawning migrations historically began in late March or early April and lasted 2-3 weeks (Cook 1940; Goode 1884; Hile 1954; MSBFC 1895; Rathbun and Wakeham 1897; Westerman 1927). Spawning began when the water temperature reached 40°F and continued until the temperature reached 50-55°F (Cook 1940).

Commercial fishermen reported that spawning usually began after ice breakup (Martin 1939b; Organ et al. 1978); others reported that spawning occurred under the ice in Saginaw Bay (Eschmeyer 1950; Westerman 1927). Between 1929 and 1956, more than 50% of the commercial catch was made in April (Hile and Buettner 1959).

The increased turbidity and siltation in Saginaw Bay in the 1940s was suggested as a cause for the decline in spawning populations in the bay and for the deterioration of spawning runs to areas near the mouth of the Saginaw River (43°39', 83°51') and its tributaries. The deterioration began in the last century; the runs persisted until water quality became too severe in the 1940s (Leach et al. 1977; Schneider and Leach 1977). The major decline occurred in 1944 (Schneider and Leach 1979). The installation of dams on the tributaries also adversely affected spawning runs (Leach et al. 1977).

The inner bay and its tributaries served as the major spawning and nursery areas until the 1940s (Schneider 1977; Schneider and Leach 1977, 1979). Spawning occurred all along the shore of the bay and in the shallow areas, including the Charity Islands (44°01', 83°27') and Coreyon Reef (44°00', 83°28'--43°40', 83°50'), over a variety of substrates (Organ et al. 1978). Many of these areas were not used after the 1930s and 1940s, but in some areas along the southeast shore and in the outer portion of the bay, spawners are still being caught (Organ et al. 1978).

Eggs were collected from fish at Caseville (43°57', 83°17') and Point Au Gres (43°59', 83°41'), but the prime spawning areas in the bay were off the mouth of the Saginaw River; along the shores of the inner bay as far as 19 mi from the river mouth; along the shore between Quanicasse (43°35', 83°40') and Fish Point (43°43', 83°31'); along the outer edges of the islands between Sebewaing (43°44', 83°27') and Bay Port (43°51', 83°22'); and on Coreyon Reef, a shallow bar extending from the mouth of the Saginaw River to the Charity Islands. Spawning also took place along the west shore of the bay between Rifle Bar (43°58', 83°43') and Nayanquing Point (43°46', 83°56') (MSBFC 1890; Schneider 1977; Schneider and Leach 1979).

The Saginaw River supported larger spawning concentrations than the other tributaries to the bay (Rathbun and Wakeham 1897; Schneider 1977). As early as the 1870s, large numbers of spawners were seined at the mouth of the river as soon as the ice broke up (Milner 1874a). Seine fisheries were also carried out near the Kawkawlin (43°40', 83°53'), Pine (43°59', 83°51'), and Rifle (44°00', 83°45') rivers (MSBFC 1890; Schneider 1977). In 1976, one ripe male was caught near the mouth of the Saginaw River at the end of April, and five juveniles 9-10 in. long were taken at the end of June (Beak Consult. 1976). A few "prejuveniles" were also entrained in late June and early August at the Karn-Weadock Power Plant Complex (43°39', 83°51') (Consumers Power 1976c). The first run in the Quanicasse River (43°35', 83°41') since the 1940s occurred in 1980 (Mainville 1980).

MH-5, MH-6

Harbor Beach (43°51', 82°39')--St. Clair River (43°00', 82°25'). Commercial fishermen reported that spawning occurs along the shore from Harbor Beach south to Burtchville Park (43°08', 82°30') over a substrate of mud, sand, and rock within the 30 ft depth contour (Organ et al. 1978). Spawning runs entered streams along the Lake Huron south shore and the St. Clair River (Rathbun and Wakeham 1897). In 1935, runs occurred in all waters south of Forester (43°30', 82°34') (Hile 1937).

Walleyes are presently believed to migrate from Lake Huron into the St. Clair River to spawn in May (Ferguson and Derkson 1971; Schneider and Leach 1977). Tagged walleyes have also migrated into Lake Huron, after spawning in the Thames River (42°19', 82°27') in Lake St. Clair (Ferguson and Derkson 1971; Int. Great Lakes Level Board 1973).

Ontario

OH-4

Maitland River (43°45', 81°44'). A spawning run enters the river in the spring after the sucker run begins (Moccia, pers. comm. 1979).

OH-5

Spawning occurs on shoals along the southeast shore of the main lake basin (Spangler et al. 1977). Spawn was collected in the southern portion of the lake (Ont. Game Fish 1939). In the early part of the century, eggs were obtained from fish on seining grounds at Sarnia (43°00', 82°24') and Point Edward (43°00', 82°25') (Can. Dep. Mar. Fish. 1905; Rodd 1913, 1914).

Healthy stocks of walleyes existed in Georgian Bay in the mid-1970s (Schneider and Leach 1977), and there appear to be several discrete stocks that spawn there (Winterton 1975). Spawning occurs at 38-40°F; the numerous rivers along the east shore of the bay provide extensive areas of rapids which are ideal spawning grounds (MacKay 1958e, 1969). Historically, spawning occurred in late April-early May, just after ice out (Bensley 1915; Rathbun and Wakeham 1897). In 1931, it was suggested that the southeastern portion of the bay, along with inshore areas of the north shore, be closed to provide a "spawning sanctuary" (Ont. Game Fish 1931). Walleye reproduction has been reported in the following areas of Georgian Bay:

The North Channel was a prime walleye spawn collecting area (Ont. Game Fish 1913a). Spawning declined during the 1930s, but healthy stocks of walleyes existed in portions of the North Channel in the mid-1970s (Schneider and Leach 1977, 1979).

NC-1

Blind River (46°11', 82°57')--Mississagi River (46°10', 83°01'). Spawning occurs in these rivers usually from April 20 to May 15 (Environ. Can. 1977c; Payne 1966; Spangler et al. 1977). Spawning may also occur along shore between the rivers (Payne 1966), where ripe adults have been seen (Spangler et al. 1977). A gradual decline in this stock occurred in the 1930s, possibly due to sedimentation (Schneider and Leach 1979).

NC-2

Spanish River (46°11', 82°19'). Paper mill pollution was thought to have caused the decline of the walleyes spawning in the river in the 1920s (Schneider and Leach 1977, 1979).

Little Current (45°59', 81°56'). This was a prime area for spawn collection (Ont. Game Fish 1913a, 1943, 1948); the streams and rivers here were full of walleyes until at least mid-May (Ont. Game Fish 1945).

Whitefish River (46°07', 81°44'). Spawn was collected at Whitefish Falls (46°07', 81°45') (Ont. Game Fish 1945; Ont. Dep. Lands Forests 1948).

NC-3

McGregor Bay (46°01', 81°43'). Spawning walleyes were observed in the channels between islands in the bay (Zimmerman 1967).

GB-3

French River (45°56', 80°54'). One of the major Georgian Bay stocks spawns here (Schneider and Leach 1979).

Magnetawan River (45°46', 80°38'). Walleyes were plentiful on the rapids on May 8 (Ont. Game Fish 1913a); they began arriving on the spawning grounds in early May, and some were still found there in late May (Ont. Game Fish 1912).

Bayfield-Nares Inlet (45°34', 80°31'). A shoal-spawning stock of walleyes uses this area (Spangler et al. 1977).

Sturgeon Bay (45°36', 80°24'). The "pickerel" left the bay by early May after spawning (Ont. Game Fish 1912).

Shawanaga River (45°32', 80°23'). A relatively discrete population spawns in the river (Zimmerman 1966, 1967). The basin is suspected by sportsmen of being the primary spawning ground for most walleyes in the Pointe au Baril (45°34', 80°30') region (Zimmerman 1967). Spawn collection from ripe fish at Shawanaga (45°31', 80°23') occurred as early as 1915 (Rodd 1917). The spawners apparently come from the nearshore areas, as there is no migration from the offshore fishing grounds. In 1965, spawning was completed by May 15-16 (Zimmerman 1967); in 1966, spawning was still occurring on May 7-9 (Zimmerman 1966); and in 1967 most spawning was completed by May 10 (Zimmerman 1967). The spawning site is 2 mi upstream, just below the first falls, and has a substrate of large boulders and smooth bedrock. The lack of smaller rubble and gravel may be affecting spawning success (Winterton 1970). Most of the spawners remain in the basin until the end of June and then move out into the bay; some then move out to Groundhog Island (45°32', 80°30'). About 95% of the tagged fish were recovered within 5 mi of the basin, and the population is not considered to be migratory (Ont. Dep. Lands Forests 1968; Zimmerman 1967). Another population spawns on the shoals of Groundhog Island, just off the Shawanaga River. Spawning occurs from mid-April to the end of May; peak spawning occurs in the first 2 weeks of May (Spangler et al. 1977; Winterton 1970; Zimmerman 1966, 1967).

Carolyn Island (45°30', 80°29') and Woodland Islands (45°33', 80°30'). Spawning occurs here (Environ. Can. 1977c).

Sequin River (45°20', 80°02') and Spider Lake (45°13', 80°01'). Spawning occurs here (Environ. Can. 1977c), but it is not known if these fish are migrants from Lake Huron.

Blackstone River (45°11', 80°00'). Some walleyes from the Moon River stock also spawn here when there is suitable flow in the river (Winterton 1972, 1975). Spawning occurs in Blackstone Harbour (45°10', 79°59') (Environ. Can. 1977c).

Moon River (45°08', 79°59'). A large stock of walleye enters this river to spawn (Ont. Dep. Lands Forests 1969, 1971; Spangler et al. 1977; Winterton 1972, 1975). Spawning occurs consistently below the first falls, over rubble in a pool on the south side; if the flow there is too great, spawning occurs further downstream. Spawning usually takes place from mid-April to the end of May; peak spawning occurs during the first 2 weeks of May. Ripe and spent females have been found in the river throughout this period, and naturally recruited fry have been found moving downstream (Thurston 1973, 1975). Spent walleyes move to onshore areas throughout the islands during May and June, and in July they migrate to offshore shoals. Over 90% move to the Watchers Islands (44°57', 80°04'), about 21 mi S; the remainder move north to Sandy Island (45°16', 80°16'). In October and November, walleyes return to the Moon River Islands (45°09', 80°01'), where they remain until spawning season (Winterton 1972, 1975).

GB-4

Cognashene Lake (44°57', 79°55'), Longuissa Bay (44°58', 79°53'), and Musquash River (44°58', 79°53'). Spawning occurs here (Environ. Can. 1977c). In 1910, the walleye had not yet arrived in the Musquash River on April 25 (Ont. Game Fish 1911); in 1911, all fish were spent by the second week of May (Ont. Game Fish 1912).

Port Severn (44°48', 79°43'). The Severn River (44°53', 79°42') supports a major walleye stock (Schneider and Leach 1979). Spawning runs occur here, and the spawning grounds lie between the Highway 103 bridge and the dams on the Trent-Severn Waterway. In 1974, walleyes arrived here on April 22 and completed spawning by May 2 (Hogg 1974). In 1977, eggs were first found on April 20 when the water temperature was about 47°F;

some larvae were collected on May 5 (Loftus 1977). Spawning occurs over gravel in the fast, shallow water near the locks (Townes 1976). A major spawning area is in swift current adjacent to the small spillway just north of the locks (Townes, undated).

Waubashene (44°45', 79°43') and Nottawasaga Bay (44°40', 80°15'). Walleyes were fished at the head of the bays, where they moved into rivers even under the ice (Rathbun and Wakeham 1897). Many walleyes have been captured in the Nottawasaga River (44°33', 80°00') in April-July (Dahl and McDonald 1980).

Port Severn (44°48', 79°43'). The Severn River (44°53', 79°42') supports a major walleye stock (Schneider and Leach 1979). Spawning runs occur here, and the spawning grounds lie between the Highway 103 bridge and the dams on the Trent-Severn Waterway. In 1974, walleyes arrived here on April 22 and completed spawning by May 2 (Hogg 1974). In 1977, eggs were first found on April 20 when the water temperature was about 47°F; some larvae were collected on May 5 (Loftus 1977). Spawning occurs over gravel in the fast, shallow water near the locks (Townes 1976). A major spawning area is in swift current adjacent to the small spillway just north of the locks (Townes, undated).

FRESHWATER DRUM

Spawning by freshwater drum is limited in Lake Huron because the water temperature required for spawning (70°F) is reached only for a short time in most areas of the lake (Daiber 1950).

Michigan

MH-4

Saginaw Bay (44°00', 83°30'). The greatest numbers of drum occur in Saginaw Bay. Spawning occurs from Wigwam Bay (43°59', 83°50) to Saganing Bar (43°55', 83°51') over sand and vegetation at depths of about 4-10 ft (Organ et al. 1978). Fry were collected at the discharge of the Karn-Weadock Power Plant Complex (43°39', 83°51') in late June and late September (Beak Consult. 1976).

SLIMY SCULPIN

Ontario

OH-3

Douglas Point (44°19', 81°36'). In 1975, larvae were found here in moderate numbers in mid- to late July (Kelso and Leslie 1979).

FOURHORN SCULPIN

Michigan

In 1975 and 1978, very small numbers of larvae were found in the nearshore waters of St. Martin Bay (46°00', 84°37'), Hammond Bay (45°30', 84°05'), Thompsons Harbor (45°21', 83°36'), Thunder Bay (45°00', 83°20'), and off Point Au Gres (43°59', 83°41') in late April through May (O'Gorman 1975, 1978). Upwellings may have swept these larvae into the nearshore waters from their normal deepwater habitat (O'Gorman 1975).

MH-2

Rockport (45°12', 83°23'). Postlarvae of this species made up 15% of the total catch of larvae in April and May (Tex. Instrum. 1979b,c).

MH-4

Alabaster (44°11', 83°33'). Postlarvae of this species made up 8% of the total catch of larvae (Tex. Instrum. 1979b,d).

MH-5

Harbor Beach (43°51', 82°39'). A few larvae were collected here over a substrate of boulders and rocks (LaJeone, pers. comm. 1979).

Ontario

OH-1

South Bay (45°38', 81°52'). In the late 1960s, postlarvae were found in small numbers along shore in April and May immediately after ice breakup. Larvae were numerous in certain years just outside the entrance of the bay. Larvae may move into the bay after hatching in the lake or may hatch in the bay before ice breakup (Faber 1970). In 1977, larvae were numerous in the bay (Loftus 1977).

OH-3

Douglas Point (44°19', 81°36'). Fourhorn sculpin larvae were collected here (Dunford 1978b) and were abundant in April through June (Dunstall 1978a; Kelso and Leslie 1979). Larvae were entrained at the Bruce Generating Station in April through June at water temperatures of about 37-54°F; eggs were entrained in April (Dunstall 1978a).

GB-4

Meaford (44°37', 80°35'). In 1977, larvae were captured in late April and early May, and spawning may occur here (Loftus 1977).

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This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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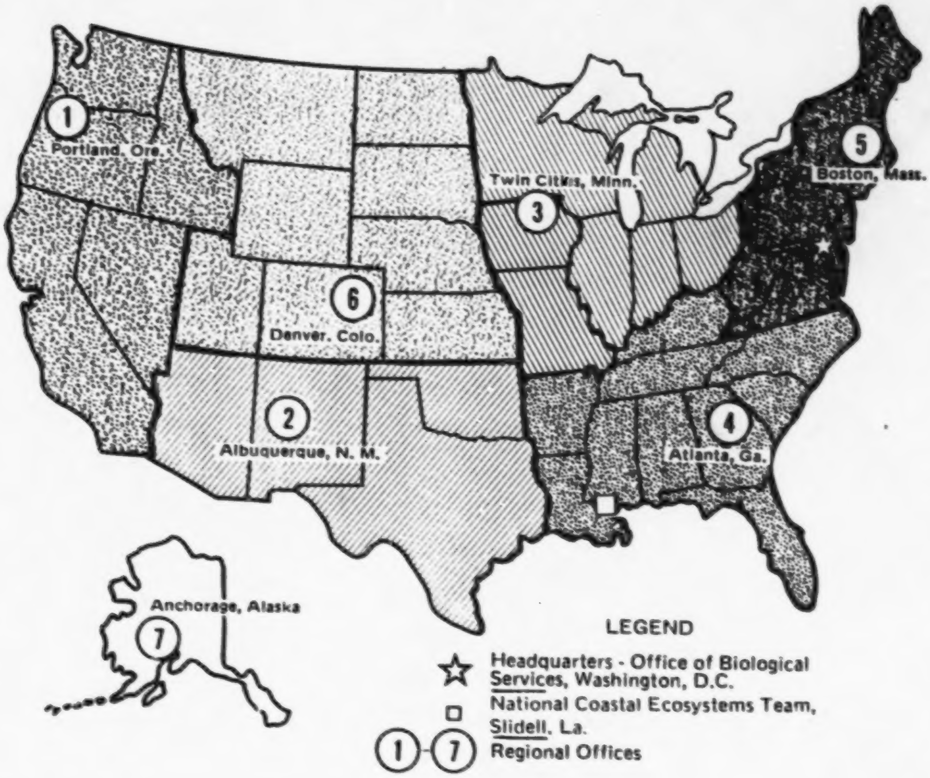
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Volume VI-St. Clair River

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME VI
St. Clair River

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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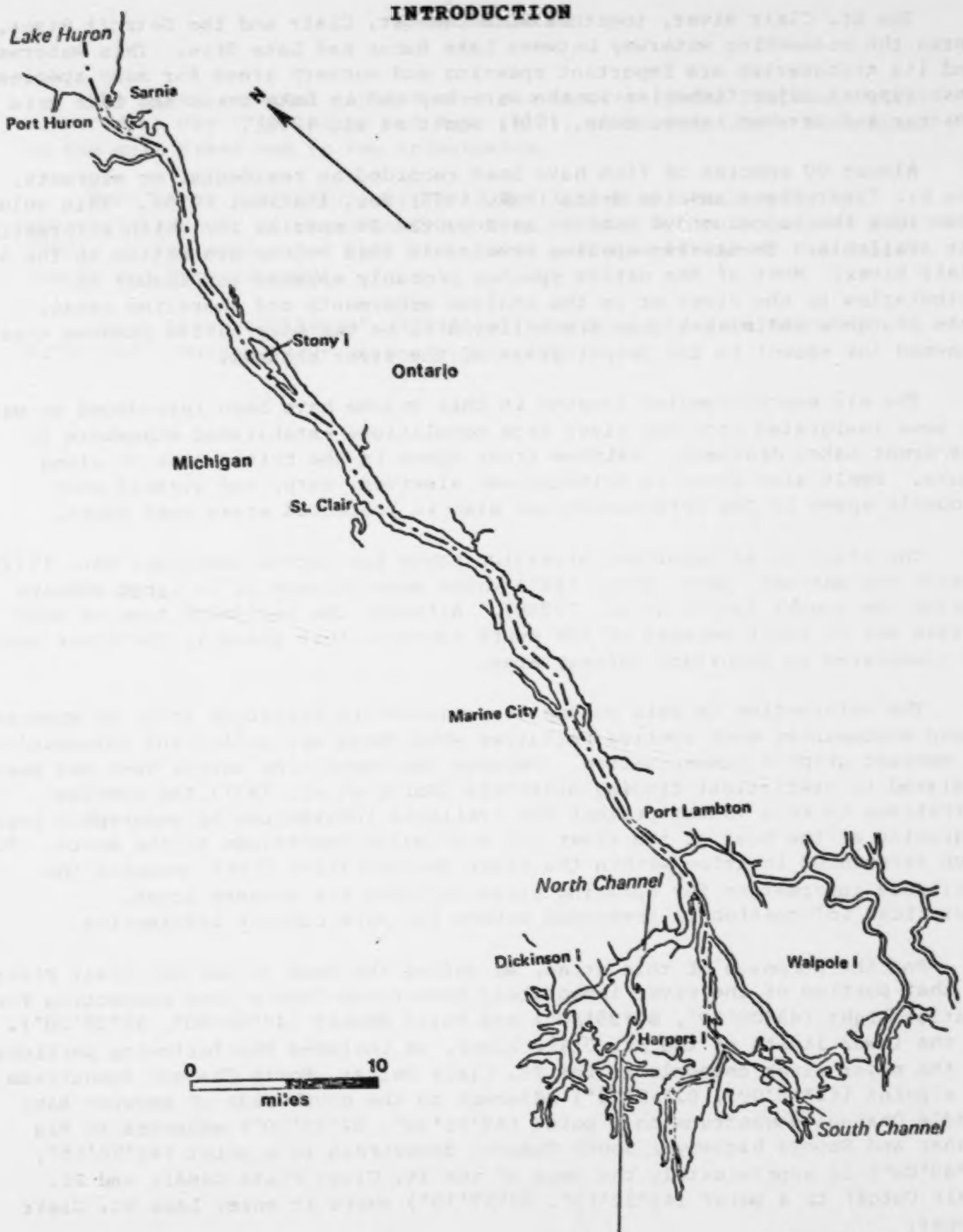
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Lake St. Clair
Middle Channel

The St. Clair River, together with Lake St. Clair and the Detroit River, forms the connecting waterway between Lake Huron and Lake Erie. This waterway and its tributaries are important spawning and nursery areas for many species that support major fisheries in the waterway and in Lake Huron and Lake Erie (Nester and Hatcher, pers. comm. 1981; Scott et al. 1978).

Almost 90 species of fish have been recorded as residents, or migrants, in the St. Clair River and its delta (MWRC 1975; Tex. Instrum. 1975). This volume describes the reproductive habitat used by the 28 species for which information was available. Twenty-two species treated in this volume are native to the St. Clair River. Most of the native species probably spawned (or spawn) in tributaries to the river or in the shallow embayments and shoreline areas. Lake sturgeon and muskellunge are believed to be the only native species that spawned (or spawn) in the deeper areas of the river channel.

The six exotic species treated in this volume have been introduced by man or have immigrated into the river from populations established elsewhere in the Great Lakes drainage. Rainbow trout spawn in the tributaries or along shore. Smelt also spawn in tributaries; alewives, carp, and gizzard shad probably spawn in the tributaries and also in protected areas near shore.

The river is an important migration route for larvae (Environ. Can. 1977a; Nester and Hatcher, pers. comm. 1981) which move through it in large numbers during the summer (Scott et al. 1978b). Although the residence time of most larvae may be short because of the swift currents that prevail, the river must be considered an important nursery area.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Because the connecting waters have not been assigned to statistical fishing districts (Smith et al. 1971) the species narratives in this volume present the available information by geographic area beginning at the head of the river and continuing downstream to the mouth. For each referenced location within the river the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

For the purposes of this atlas, we define the head of the St. Clair River as that portion of the river immediately downstream from a line connecting Fort Gratiot Light (43°00'30", 82°25'30") and Point Edward (43°00'00", 82°25'00"). As the lower limits of the St. Clair River, we included the following portions of the major river channels in the St. Clair Delta: North Channel downstream to a point (42°38'00", 82°39'15") adjacent to the south side of Bouvier Bay; Middle Channel downstream to a point (42°35'30", 82°38'30") adjacent to Big Fisher and Snooks highways; South Channel downstream to a point (42°30'15", 82°40'00") at approximately the head of the St. Clair Flats Canal; and St. Clair Cutoff to a point (42°32'15", 82°37'30") where it enter Lake St. Clair proper.

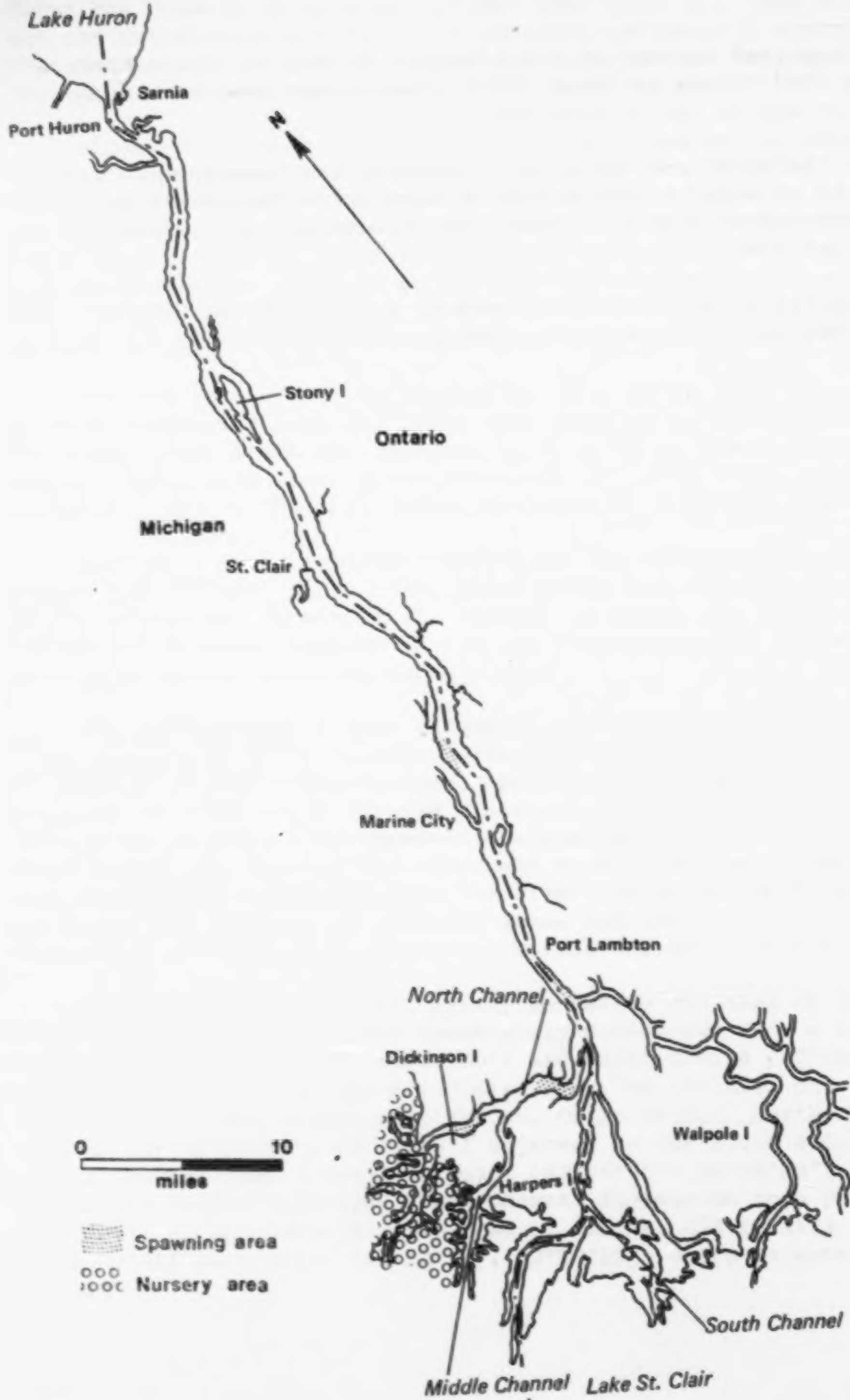
SEA LAMPREY

The first reported capture of a sea lamprey in the St. Clair River occurred in May 1930 (Hubbs and Pope 1937). Ammocoetes have been found in the main river and in two tributaries.

Port Huron (42°58'30", 82°25'30"). A nesting sea lamprey was observed in 12 ft of water at the outlet of Lake Huron (Morman et al. 1980). A few ammocoetes have been found just downstream of the outlet (Smith and Tibbles 1980).

Black River (42°58'20", 82°25'10") and Pine River (42°49'15", 82°29'10") (Morman 1979; Pearce et al. 1980).

LAKE STURGEON


Lake Huron
Sarnia
Port Huron
N
Stony I
Ontario
Michigan
St. Clair
Marine City
Port Lambton
North Channel
Dickinson I
Walpole I
Harpers I
0
10
miles
Spawning area
Nursery area
South Channel
Middle Channel
Lake St. Clair

The St. Clair River has been identified as a sturgeon spawning ground (U.S. Army Eng. Dist. 1979). Spawning begins in the river about mid-May (Dalton, Hill, Kandt, Shell, and Tyrrell, pers. comm. 1979).

Port Huron (42°58'30", 82°25'30"). One sturgeon larva was collected at Port Huron in 1977 (Nester and Hatcher, pers. comm. 1979).

Marine City (42°43'00", 82°30'00"). Ripe adults are caught north of Marine City at 42°44'00", 82°29'00" (Hill, pers. comm. 1979; Shell, pers. comm. 1979).

Port Lambton (42°39'20", 82°30'00")--Baby Point (42°38'30", 82°30'00"). Ripe adults are caught here. Most sturgeon leave the area in mid-June (Hill, pers. comm. 1979; Tyrrell, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). The channels of the river delta are major spawning areas (Int. Great Lakes Levels Board 1973). In 1890, a few ripe and spent fish were captured in June in the North Channel (42°37'30", 82°37'00") for the Algonac hatchery (MSBFC 1890; Post 1890). Ripe fish are presently taken in May and June from deep holes in the North Channel.

> Point aux Chenes (42°36'40", 82°32'40"). For many years ripe adults were caught in the 60-82 ft "hole" (42°36'30", 82°32'30") off the point over a bottom of rock, sand, and coal cinders (Dalton, Hill, Kandt, and Shell, pers. comm. 1979; Organ et al. 1978; Trombley, pers. comm. 1979; Tyrrell, pers. comm. 1979). Sturgeon migrate from Lake St. Clair up the North (42°37'30", 82°37'00"), South (42°33'00", 82°39'00"), and Middle (42°35'35", 82°37'30") channels to this spawning site. Young-of-the-year subsequently migrate from this area to the marsh (42°37'30", 82°39'30") between Bouvier (42°39'30", 82°39'00") and Goose (42°35'30", 82°40'30") bays, where they are found among the rushes (Trombley, pers. comm. 1979).
>
> Belle Harbor (42°37'30", 82°37'10"). Ripe adults are caught in the 51 ft "hole" off Belle Harbor over a bottom of gravel, sand, and coal cinders (Hill, pers. comm.; Kandt, pers. comm. 1979).

ALEWIFE

The alewife presumably entered the St. Clair River from Lake St. Clair between 1931 and 1933, when alewives were first recorded for Lake Erie and Lake Huron, respectively (Miller 1957). Impingement records at power plants along the river indicate that spawning runs of alewives occur in the St. Clair River in the spring. Young-of-the-year are impinged during the fall when they migrate downstream (Detroit Edison 1976a,f).

Port Huron (42°58'30", 82°25'30"). In 1977, alewife larvae were collected in June to August; these probably originated from spawnings in Lake Huron (Nester and Hatcher, pers. comm. 1979).

Black River (45°58'20", 82°25'10"). In 1964-68, many alewives entered the river in the spring and migrated about 5 mi upstream to spawn (Nester, pers. comm. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, alewife eggs and larvae were collected in the St. Clair River near the plant from June to August when water temperatures were about 52-68°F; most were concentrated in the shallow, slower water along the Canadian shore. Spawning probably occurred near the plant or in areas further upstream. Spawning peaked from late June to mid-July (Tex. Instrum. 1975a).

Baby Point (42°38'30", 82°30'00"). In 1977, larvae were collected here from late June to late August; peak abundance occurred in late July (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, alewife larvae were collected in the North Channel at 42°38'00", 82°39'15" from late June to late August and in the St. Clair Cutoff at 42°32'15", 82°37'30" from early July to late August. Peak abundance occurred in late July (Nester and Hatcher, pers. comm. 1979).

GIZZARD SHAD

The gizzard shad presumably entered the St. Clair River from Lake St. Clair between 1848 and 1877, when gizzard shad were first recorded for Lake Erie and Lake Huron, respectively (Miller 1957). Impingement records at power plants along the river indicate that spawning runs occur in the St. Clair River in the spring (Detroit Edison 1976a,f).

Port Huron (42°58'30", 82°25'30"). In 1977, a few larvae were collected in July, these probably originated from spawnings in Lake Huron (Nester and Hatcher, pers. comm. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, a few larvae were collected near the power plant in May and June at water temperatures of 50-55°F; spawning may not have occurred in the river at this time because few ripe and spent fish were taken (Tex. Instrum. 1975a; Wapora 1978).

Baby Point (42°38'30", 82°30'15"). In 1977, a few larvae were collected in late May to mid-July (Nester and Hatcher, pers. comm. 1979); these were probably in transit from spawning areas farther upstream.

St. Clair Delta (42°37'00", 82°31'00"). In 1977, a few larvae were collected in the St. Clair Cuttoff at 42°32'15", 82°37'30" in July and in the North Channel at 42°38'00", 82°39'15" in late May to August; these larvae were probably in transit from spawning areas farther upstream (Nester and Hatcher, pers. comm. 1979).

LAKE HERRING

Large spawning runs of lake herring occurred historically in the St. Clair River, but these disappeared by the early 1900s (Smith 1972).

Lambton County, Ontario (42°45'00", 82°25'00"). In 1913, a heavy spawning run occurred in the fall (Ont. Game Fish 1913a).

LAKE WHITEFISH

The large spawning runs of lake whitefish that historically entered the St. Clair River from Lake Erie disappeared by the late 1800s or early 1900s (MSBFC 1887; Smith 1972). By 1874, the runs that formerly moved upstream to Mooretown, Ontario (42°50'30", 82°27'45"), about 8 mi from the head of the river (Stockwell 1875a), were decreasing and only proceeded as far as Cottrelville (location uncertain), 12 mi upstream from the river mouth (Milner 1874a). The runs apparently persisted at least until 1887, when the Michigan Fish Commission collected eggs from the St. Clair River (Langlois 1941), but by 1910, the whitefish run had disappeared (Reighard 1910; Wright 1955). Adults were rarely observed entering the St. Clair River from Lake Huron to spawn (Milner 1874a; Stockwell 1875a).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1978, one larva was reported in entrainment samples collected at the plant in April (Wapora 1978).

Baby Point (42°38'30", 82°30'15"). In 1977 and 1978, one whitefish larva was collected each year (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1978, three larvae were collected in the North Channel at (42°38'00", 82°39'15") (Nester and Hatcher, pers. comm. 1979).

RAINBOW TROUT

No records describing the introduction of rainbow (steelhead) trout in the St. Clair River were located. Presumably, rainbow trout entered the river from Lake Huron. The St. Clair River supports a spawning run of rainbow trout (Ann Arbor News 1979a).

Fort Gratiot Light (43°00'30", 82°25'30"). Spawning has been observed over gravel bottom near the lighthouse at the head of the river (Hill, pers. comm. 1979).

Black River (42°58'20", 82°25'10"). Spawning migrations enter the Black River and its tributary, Mill Creek (Hill, pers. comm. 1979).

LAKE TROUT

Spawning runs of lake trout were common in the St. Clair River but disappeared by the early 1900s (Smith 1972).

SALMON spp.

Black River (42°58'20", 82°25'10"). Salmon enter the Black River and its tributary, Mill Creek, to spawn (Hill, pers. comm. 1979).

SALMONID spp.

St. Clair Power Plant (42°45'45", 82°28'15"). In 1978, eggs of an unidentified salmonid were collected in May along the Canadian shore across the river from the power plant (Wapora 1978).

RAINBOW SMELT

Rainbow smelt eggs planted in Crystal Lake (44°40', 86°10') in the Lake Michigan drainage in 1912 are believed to be the source of smelt found in all of the Great Lakes except Lake Ontario. The first record of rainbow smelt in the St. Clair River was established in 1932, when they entered the river from Lake Huron (Van Oosten 1937a). Impingement of adults at power plants along the river increases in the spring when spawning runs occur. Eggs are found in the river and in entrainment samples collected at power plants in April to June (Detroit Edison 1976a,f).

Port Huron (42°58'30", 82°25'30"). In 1944, the spawning run started on April 21 (Van Oosten 1944b). In 1979, the run started on April 19 (UPI 1979). In 1977, smelt larvae were collected from early May to mid-June (Nester and Hatcher, pers. comm. 1979).

Marysville (42°54'45", 82°28'00"). The number of adults impinged at the Marysville Power Plant (42°55'30", 82°27'35") increases during the spring spawning run. Eggs and larvae have been entrained at the plant, and young smelt have been impinged in the fall (Detroit Edison 1976f).

Lambton Generating Station (42°47'30", 82°28'20"). In 1978, larvae were captured from April 25 to June 21; the peak catch occurred in late May. If hatching required 2-3 weeks, spawning probably peaked during the first 2 weeks of May, when water temperatures were about 43-46°F (Kozopas and Leslie 1979; Leslie et al. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). Smelt spawn here soon after ice breakup, usually during late March to April when water temperatures are below 42°F (Detroit Edison 1976a). In 1974, eggs were collected from late May through early June at water temperatures of 48-55°F; peak spawning occurred earlier. Concentrations of eggs were higher in the slower, shallower water near the Canadian shore than at mid-river or along the U.S. shore (Tex. Instrum. 1975a). In 1978, eggs were collected from early April to early June, and were most abundant on the Canadian shore on May 11 (Wapora 1978). In 1974 and 1975, larvae were collected in entrainment samples at the St. Clair Power Plant (Detroit Edison 1976a) and in the river near the plant from May to August. Peak concentrations occurred in the river on May 31; greater concentrations of larvae occurred near the Canadian shore, but there was no significant difference between stations (Tex. Instrum. 1975a). In 1974, young-of-the-year were abundant in collections made from mid-August to late October (Tex. Instrum. 1975a; Detroit Edison 1976a,f).

Baby Point (42°38'30", 82°30'15"). In 1977, smelt larvae were collected here from early May to early July; peak abundance occurred in mid-May (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, smelt larvae were collected in the North Channel at 42°38'00", 82°39'15" from early May to early July and in the St. Clair Cutoff at 42°32'15", 82°37'30" from early May to mid-June. Peak abundance of larvae occurred during May (Nester and Hatcher, pers. comm. 1979).

MUSKELLUNGE

St. Clair Delta (42°37'00", 82°31'00"). Muskellunge are believed to spawn in the channels of the delta where there is adequate current (Williams 1961).

CARP

Substantial populations of carp were present in the St. Clair River prior to 1900; presumably these fish originated from plantings made in

Michigan's inland waters during the 1880s or from populations in Lake St. Clair (McCrimmon 1968). Spawning occurs in the St. Clair River during June at water temperatures of about 56°F (Tex. Instrum. 1975a).

Port Huron (42°58'30", 82°25'30"). In 1977, larvae were collected here in June to August (Nester and Hatcher, pers. comm. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). Eggs were collected near the plant from June to August at water temperatures of about 52-68°F. Larvae were collected in the same areas in June and July at water temperatures of about 52-62°F (Tex. Instrum. 1975a).

Baby Point (42°38'30", 82°30'15"). In 1977, a few carp larvae were collected from late June to early August (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). During 1977, larvae were collected in the St. Clair Cutoff at 42°32'15", 82°37'30" from late May to July and in the North Channel at 42°38'00", 82°39'15" from June to July. Larval abundance peaked during the first or second week of July (Nester and Hatcher, pers. comm. 1979).

SILVER CHUB

Lambton Generating Station (42°47'45", 82°28'20"). In 1978, silver chub larvae were 1.5% of the total catch of larvae made near the station in mid-June (Kozopas and Leslie 1979; Leslie et al. 1979).

EMERALD SHINER

Baby Point (42°38'30", 82°30'15"). In 1977, a few emerald shiner larvae were collected from late June to late August; abundance peaked in late July (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, a few larvae were collected in the St. Clair Cutoff at 42°32'15", 82°37'30" from mid-June to early August and in the North Channel at 42°38'00", 82°39'15" from mid-July to early August. Peak abundance occurred in early August (Nester and Hatcher, pers. comm. 1979).

MINNOW spp.

Port Huron (42°58'30", 82°25'30"). In 1977, larvae of unidentified species of minnows were collected from early June to early August; peak abundance occurred in early June and mid-July (Nester and Hatcher, pers. comm. 1979).

Baby Point (42°38'30", 82°30'15"). In 1977, minnow larvae were collected from early June to early August; peak abundance occurred in mid-July and early August (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, minnow larvae were collected in the North Channel at 42°38'00", 82°39'15" and St. Clair Cutoff at 42°32'15", 82°37'30" from late May to early August; peak abundance occurred in early June (Nester and Hatcher, pers. comm. 1979).

WHITE SUCKER

Port Huron (42°58'30", 82°25'30"). In 1977, larvae were collected here from early June to early July (Nester and Hatcher, pers. comm. 1979).

Lambton Power Plant (42°47'45", 82°28'20"). In 1978, small numbers of larvae were entrained in mid-June (Leslie et al. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, white sucker eggs were collected near the St. Clair Power Plant on June 20, at water temperatures of 48-55°F; larvae were collected from early June through early August. In 1974, white sucker young-of-the-year (YOY) were more abundant than the YOY of most other species during August (Tex. Instrum. 1975a) but were not as numerous in 1978 (Wapora 1978).

Baby Point (42°38'30", 82°30'15"). In 1977, white sucker larvae were collected from late May to mid-July; peak abundance occurred in early June and early July (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, larvae were collected in the St. Clair Cutoff at 42°32'15", 82°37'30" from early June to mid-July; peak abundance occurred during late June. They were also found in the North Channel at 42°38'00", 82°39'15" during June and early July; peak abundance occurred in early June (Nester and Hatcher, pers. comm. 1979).

NORTHERN HOG SUCKER

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, young-of-the year (YOY) of this species were more abundant than the YOY of most other species collected near the power plant during August (Tex. Instrum. 1975a).

SUCKER spp.

Spawning runs of "black" suckers occur in most tributaries of the St. Clair River (Shell and Tyrrell, pers. comm. 1979).

Black River (42°58'20", 82°25'10"). A run of "black" suckers enters the river and its tributary Mill Creek (Shell and Tyrrell, pers. comm. 1979).

Pine River (42°49'15", 82°29'10") and Belle River (42°42'25", 82°29'50"). Spawning runs of "black" suckers enter the rivers (Shell and Tyrrell, pers. comm. 1979).

REDHORSE spp.

Black River (42°58'20", 82°25'10") and Belle River (42°42'25", 82°29'50"). Until about the early 1950s, major spawning runs of redhorses entered these rivers (Kandt, pers. comm. 1979).

BROWN BULLHEAD

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, brown bullhead larvae were collected near the plant on August 21, when water temperatures were about 68-72°F (Tex. Instrum. 1975a).

TROUT-PERCH

Port Huron (42°58'30", 82°25'30"). In 1977, larvae were collected in June to August. Many were found in early June, suggesting downstream movement out of Lake Huron (Nester and Hatcher, pers. comm. 1977).

Marysville (42°54'45", 82°28'00"). In 1974-75, larvae were entrained at the Marysville Power Plant (42°55'30", 82°27'35") from June to October (Detroit Edison 1976f).

Lambton Generating Station (42°47'45", 82°28'20"). In 1978, two larvae were entrained in mid-June (Leslie et al. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974-75, larvae were entrained in July and August (Detroit Edison 1976a); larvae were collected in the river in July and September when water temperatures were about 66-72°F (Tex. Instrum. 1975a).

Baby Point (42°38'30", 82°30'15"). In 1977, a few larvae were collected from early June to early August (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, a few larvae were collected in the St. Clair Cutoff at 42°32'15", 82°37'30" in late May and early June, and in the North Channel at 42°38'00", 82°39'15" in early June and mid-July (Nester and Hatcher, pers. comm. 1979).

BURBOT

Port Huron (42°58'30", 82°25'30"). In 1977, a few young-of-the-year were collected here in late April and May (Nester and Hatcher, pers. comm. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1978, larvae were taken in April and May at all stations across the width of the river (Wapora 1978).

Baby Point (42°38'30", 82°30'15"). In 1977, a few burbot larvae were collected from late April to late May (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, a few larvae were collected in the North Channel at 42°38'00", 82°39'15" in May (Nester and Hatcher, pers. comm. 1979).

WHITE BASS

Port Huron (42°58'30", 82°25'30"). In 1977, one white bass larva was collected in late July (Nester and Hatcher, pers. comm. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, small numbers of larvae were collected near the power plant in late May to early June when water temperatures were about 50-55°F (Tex. Instrum. 1975a).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, one larva was collected in late June at 42°38'00", 82°39'15" (Nester and Hatcher, pers. comm. 1979).

ROCK BASS

St. Clair Power Plant (42°45'45", 82°28'15"). Rock bass spawn from late May to early August in the St. Clair River near the power plant, based on the collection of ripe and spent adults (Tex. Instrum. 1975a).

SMALLMOUTH BASS

Smallmouth bass presently spawn in tributaries of the St. Clair River (Dalton, pers. comm. 1979).

Stag Island (42°53'10", 82°27'50"). Spawning occurs here over "grass" bottom in water 4-5 ft deep (Shell, pers. comm. 1979). The shoals around the island may be a very important spawning area (FWS 1979d).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, fry were collected at the plant in late August when water temperatures were about 68-72°F (Tex. Instrum. 1975a).

BASS spp.

Black bass were speared on their spawning beds in the St. Clair River (Rathbun and Wakeham 1897).

Algonac (42°37'30", 82°32'15"). The principal bass grounds were in the delta off Algonac (Hardin 1894), although these were not specifically said to be spawning grounds.

YELLOW PERCH

Impingement of adult yellow perch at power plants along the river increases in the spring as spawning runs move upstream. Young-of-the-year are encountered more frequently in the fall during migrations downstream (Detroit Edison 1976a,f).

Point Edward (43°00'00", 82°25'00"). Spawning occurs here (Dalton, pers. comm. 1979).

Port Huron (42°58'30", 82°25'30"). In 1977, larvae were collected here from mid-May to late June; peak abundance occurred in mid-June (Nester and Hatcher, pers. comm. 1979).

Black River (42°58'20", 82°25'10"). Yellow perch enter the river during the spawning season (Nester, pers. comm. 1981).

Marysville (42°54'45", 82°28'00"). In 1974, adults were impinged at the Marysville Power Plant (42°55'30", 82°27'35") in the spring during spawning runs; larvae were entrained in late July (Detroit Edison 1976f).

Lambton Generating Station (42°47'45", 82°28'20"). In 1978, a few larvae were entrained during late May to late June (Leslie et al. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, yellow perch eggs were collected near the plant during late May to late August when water temperatures were about 48-72°F. Eggs were collected throughout the area, but on June 20 they were concentrated near the bottom on the Canadian side. Larvae were collected from mid-May to early September; peak abundance occurred in late June (Tex. Instrum. 1975a; Detroit Edison 1976a; Wapora 1978).

Baby Point (42°38'30", 82°30'15"). In 1977, yellow perch larvae were collected from late May to late June; peak abundance occurred in early June (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, larvae were collected in the St. Clair Cutoff at 42°32'15", 82°37'30" and in the North Channel at 42°38'00", 82°39'15" from late May to July. Peak abundance occurred at both stations during early June (Nester and Hatcher, pers. comm. 1979).

LOGPERCH

Port Huron (42°58'30", 82°25'30"). In 1977, logperch larvae were collected from late May to late August; peak abundance occurred during late May to early June (Nester and Hatcher, pers. comm. 1979).

Lambton Generating Station (42°47'45", 82°28'20"). In 1978, a few larvae were entrained in early June (Leslie et al. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, larvae were collected in the river in late May and were present in entrainment samples in late June (Detroit Edison 1976a; Wapora 1978).

Baby Point (42°38'30", 82°30'15"). In 1977, logperch larvae were collected from late May to early August; peak abundance occurred in early June (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, larvae were collected in the North Channel at 42°38'00", 82°39'15" from late May to late July, and in the St. Clair Cutoff at 42°32'15", 82°37'30" from late May to early August; peak abundance occurred during early June (Nester and Hatcher, pers. comm. 1979).

WALLEYE

The walleye run in the St. Clair River was once one of the largest runs reported for Michigan waters; this run began in May or June (MSBFC 1888). In the 1880s and 1890s, hatcheries in Michigan and Ontario obtained eggs from commercial seiners operating along the length of the river (Schneider and Leach 1977, 1979). For at least two decades starting in 1886, hatcheries in Detroit collected eggs from the Canadian side of the river (Regier et al. 1969). The Put-In-Bay hatchery obtained eggs from fishermen at Roberts Landing (42°39'30", 82°30'50") (Downing 1905; MSBFC 1893, 1895); spawn taking also occurred at Port Huron (42°58'30", 82°25'30") (MSBFC 1888). A discrete resident population spawned in the river (Nepszy 1977; Schneider and Leach 1977, 1979); these fish spawned as late as June 5-7 (Downing 1905).

The St. Clair River is part of a complex migration route, in which one or several populations of walleyes move between the St. Clair-Detroit River system and the western basin of Lake Erie (Applegate and Van Meter 1970). The river is along a post-spawning migration route for walleyes moving from the Clinton River (42°35'30", 82°47'00") and Lake Erie through the North Channel (42°37'30", 82°37'00") and for walleyes moving from the Thames River (42°19'00", 82°24'30") and Sydenham River (42°33'30", 82°24'30") through the Middle (42°35'35", 82°37'30") and South (42°33'00", 82°39'00") Channels (Schneider and Leach 1977, 1979; Tyrrell, pers. comm. 1979). Many ripe walleyes are presently caught throughout the river during May (Shell, pers. comm. 1979), but it has been suggested that no spawning occurs in the river itself (Haas and Bryant, undated).

Black River (42°58'20", 82°25'10"). Ripe walleyes enter the river (Hill, pers. comm. 1979).

Marysville (42°54'45", 82°28'10"). In 1975, walleye larvae were entrained at the Marysville Power Plant (42°55'30", 82°27'35") during April to early May (Detroit Edison 1976f).

Stag Island (42°53'10", 82°27'50"). The shoals around the island may be a valuable spawning area (FWS 1979d).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974-75, larvae were entrained from April through early July (Detroit Edison 1976a) and were collected in the river during late May to early June when water temperatures were about 50-55°F. Spent fish and one gravid female were collected in June (Tex. Instrum. 1975a).

Locust Point (42°37'45", 82°31'40")--Roberts Landing (42°39'30", 82°30'50"). Walleyes spawned across the entire width of the river in the area extending from Locust Point to about 1 mi upstream of Roberts Landing (42°40'24", 82°30'45"), but it is not known if spawning still occurs here (Organ et al. 1978).

DARTER spp.

Port Huron (42°58'30", 82°25'30"). In 1977, a few larvae of unidentified darters were collected in mid-July (Nester and Hatcher, pers. comm. 1979).

Baby Point (42°38'30", 82°30'15"). In 1977, a few larvae were collected from late June to mid-July (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). In 1977, a few larvae were collected in the St. Clair Cutoff at 42°32'30", 82°37'00" in late June and early August and in the North Channel at 42°38'00", 82°39'00" in early June (Nester and Hatcher, pers. comm. 1979).

FRESHWATER DRUM

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974-75, larvae were present in entrainment samples collected at the plant in late June and mid-July (Detroit Edison 1976a).

North Channel (42°38'00", 82°39'00"). In 1977, one freshwater drum larva was captured in the North Channel at (42°38'00", 82°39'15") during mid-June (Nester and Hatcher, pers. comm. 1979).

MOTTLED SCULPIN

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, larvae were collected here in late May when water temperatures were about 48-54°F (Tex. Instrum. 1975a).

SLIMY SCULPIN

St. Clair Power Plant (42°45'45", 82°28'15"). In 1974, larvae were collected near the plant only on July 17, when water temperatures were about 66-70°F (Tex. Instrum. 1975a).

FOURHORN SCULPIN

Port Huron (42°58'30", 82°25'30"). In 1977, a few larvae were collected during April and May (Nester and Hatcher, pers. comm. 1979).

Lambton Generating Station (42°47'45", 82°28'20"). In 1978, fourhorn sculpin larvae, probably originating from spawnings in Lake Huron in early April, made up 2% of the total catch of larvae at the plant from April 18 to May 15; peak abundance of larvae occurred on April 25-26 (Kozopas and Leslie 1979; Leslie et al. 1979).

St. Clair Power Plant (42°45'45", 82°28'15"). In 1978, larvae were collected near the plant at all stations across the width of the river from April 30 to May 17 (Wapora 1978).

Baby Point (42°38'30", 82°30'15"). In 1977, a few larvae were collected in April and May (Nester and Hatcher, pers. comm. 1979).

St. Clair Delta (42°37'00", 82°31'00"). During 1977, a few larvae were collected in the St. Clair Cutoff at 42°32'15", 82°37'30" from May to July and in the North Channel at 42°38'00", 82°39'15" in May; these larvae probably originated from spawnings in Lake Huron (Nester and Hatcher, pers. comm. 1979).

SCULPIN spp.

St. Clair Power Plant (42°45'45", 82°28'15"). In 1978, sculpin eggs were collected near the plant at all stations across the width of the river in late May and early June (Wapora 1978).

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This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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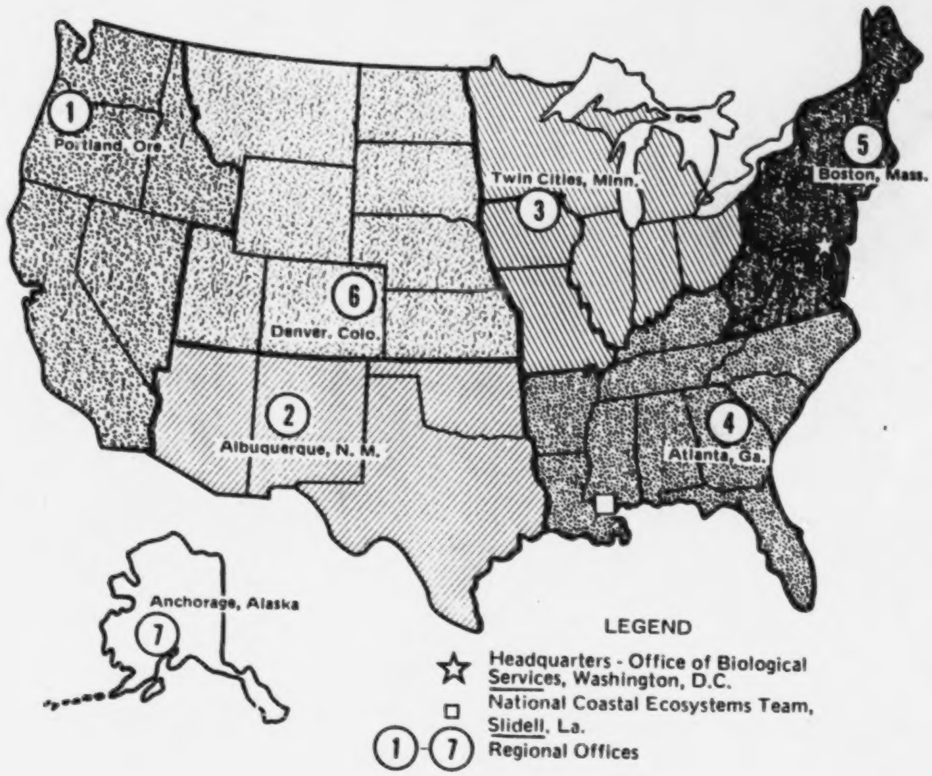
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ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume VII-St. Clair Lake

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME VII
Lake St. Clair

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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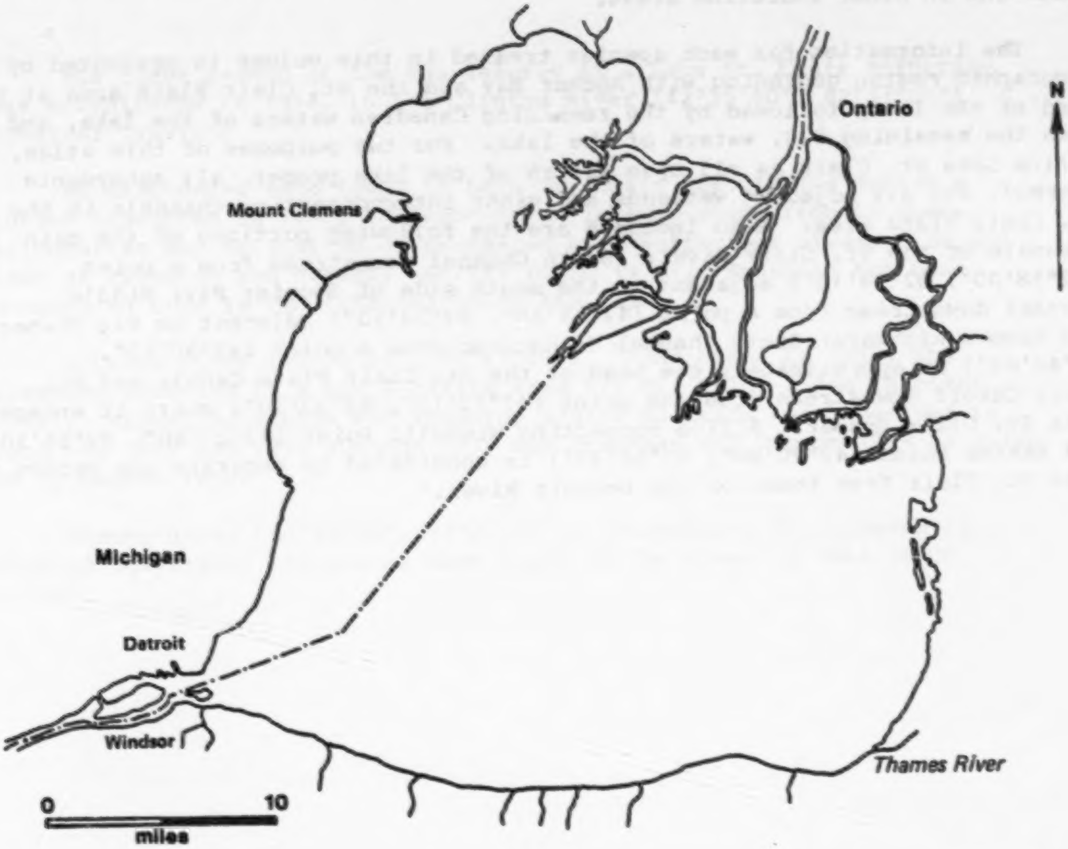
INTRODUCTION



Lake St. Clair, together with the St. Clair River and the Detroit River, forms the connecting waterway between Lake Huron and Lake Erie. The bays and wetlands of Lake St. Clair, especially in the St. Clair Flats area at the mouth of the St. Clair River, are important spawning and nursery areas for many species that support major fisheries in the waterway and in Lake Huron and Lake Erie (Environ. Can. 1977a; FWS 1979d; Int. Great Lakes Levels Board 1973; Jaworski and Raphael 1978a; MDNR 1976, 1977; Scott et al. 1978).

More than 70 species of fish have been recorded as residents, or migrants, in Lake St. Clair (FWS, unpubl. data; MDNR, undated; MWRC 1975). This volume describes the reproductive habitat used by the 34 species for which information was available. Twenty-eight species treated in this volume are native to the lake. Most of these 28 species spawned (or spawn) in the shallow, productive St. Clair Flats area, along shore, or in tributaries to the lake. Muskellunge may be the only native species that spawns in deeper areas of the lake.

The six exotic species treated in this volume have been introduced by man or have immigrated into the lake from populations established elsewhere in the

Great Lakes drainage. Smelt probably spawn in tributaries to the lake; alewives, gizzard shad, carp, and goldfish spawn in the bays and marshes of the Flats and in other shoreline areas.

The information for each species treated in this volume is presented by geographic region beginning with Anchor Bay and the St. Clair Flats area at the head of the lake, followed by the remaining Canadian waters of the lake, and then the remaining U.S. waters of the lake. For the purposes of this atlas, we define Lake St. Clair as all open waters of the lake proper, all embayments thereof, and all adjacent wetlands and minor interconnecting channels in the St. Clair Flats area. Also included are the following portions of the main channels of the St. Clair River: North Channel downstream from a point (42°38'00", 82°39'15") adjacent to the south side of Bouvier Bay; Middle Channel downstream from a point (42°35'30", 82°38'30") adjacent to Big Fisher and Snooks highways; South Channel downstream from a point (42°30'15", 82°40'00") at approximately the head of the St. Clair Flats Canal; and St. Clair Cutoff downstream from the point (42°32'15", 82°37'30") where it enters Lake St. Clair proper. A line connecting Windmill Point (42°21'30", 82°55'30") and Askins Point (42°20'00", 82°53'30") is considered to separate the waters of Lake St. Clair from those of the Detroit River.

SEA LAMPREY

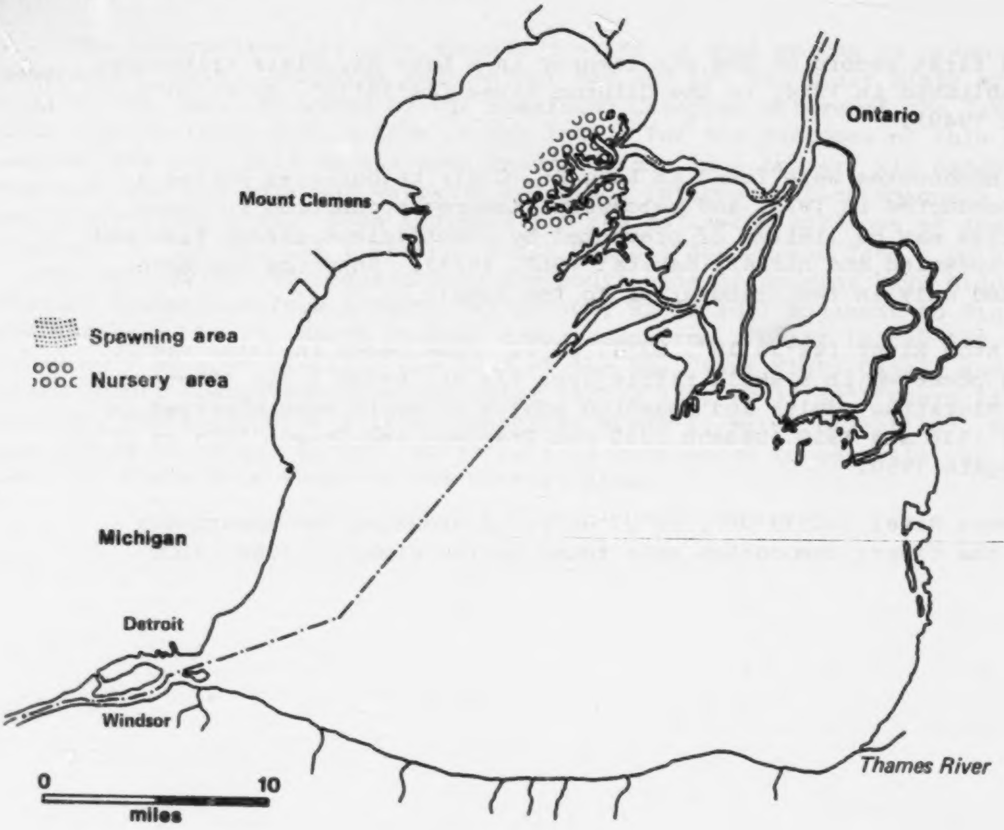
The first record of the sea lamprey in a Lake St. Clair tributary was established in 1934, in the Clinton River (42°35'30", 82°47'00") (Shetter 1949).

No ammocoetes were found in Lake St. Clair tributaries during a survey conducted in 1973, and successful lamprey production in these tributaries may be limited or prevented by insufficient stream flow and lack of spawning and nursery habitat (GLFL 1975). Spawning has been documented only in two tributaries to the lake:

Clinton River (42°35'30", 82°47'00"). Runs began in 1934, and spawning occurred in a small riffle area 1/2 mi. below a dam (Shetter 1949). Migrating adults and spawning adults on nests were observed in late May 1938 and 1939 (Deason 1939 and Trautman and Deason 1939 as cited in Applegate 1950.

Thames River (42°19'00", 82°27'00"). A spawning run apparently entered the river; ammocoetes were found in the river in 1964 (SLCC 1979a).

LAKE STURGEON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Mount Clemens
Spawning area
Nursery area
Michigan
Detroit
Windsor
Thames River
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Sturgeon spawned in some portions of Lake St. Clair in early May and June (Rathbun and Wakeham 1897); these spawners may have been residents of Lake Erie (Prince 1918).

St. Clair Flats (42°35'00", 82°40'00"). This area is an important spawning area (Environ. Can. 1977a). The major known spawning area for Lake St. Clair sturgeon is the North Channel (42°37'00", 82°37'00") of the St. Clair River (Int. Great Lakes Levels Board 1973). Sturgeon from Lake St. Clair migrate up the North, South (42°33'00", 82°39'00"), and Middle (42°35'00", 82°39'00") channels to spawn at a site (42°36'30", 82°32'30") in the North Channel; young-of-the-year sturgeon migrate from this spawning site to the marsh between Bouvier (42°39'30", 82°39'00") and Goose (42°35'00", 82°41'00") bays, where they are found among the rushes (Trombley, pers. comm. 1979).

LONGNOSE GAR

Little Muscamoot Bay (42°34'30", 82°38'00"). In 1980, many large adults were collected in the southeast corner of the bay during May (GLFL, unpubl. data).

Bradley Marsh (42°21'30", 82°25'30"). In 1971, longnose gars were observed spawning along shore near Bradley Marsh during May 29 to June 15, at water temperatures of about 67-84°F. Spawning occurred over a bottom of sand, silt, and decaying vegetation at water depths of about 6-12 in. Eggs were deposited on a wide variety of plant material (Dean 1972).

St. Clair Shores (42°30'00", 82°54'00"). During the early 1960s, young-of-the-year were observed in a canal (42°28'30", 82°53'00") south of Ten Mile Road (42°28'30", 82°53'00") (Moss, pers. comm. 1980).

BOWFIN

St. John's Marsh (42°38'30", 82°39'00"). The canals and marshes are spawning and nursery areas (MDNR 1977).

Mitchell Bay (42°28'00", 82°26'00"). An adult bowfin with a school of young (1 in. long) was observed in the blind end of a drainage area (location unknown) leading into Mitchell Bay, Ontario (Doan 1938).

ALEWIFE

The alewife presumably entered Lake St. Clair from Lake Erie via the Detroit River between 1931 and 1933, when alewives were first recorded for Lake Erie and Lake Huron, respectively (Miller 1957).

Bouvier Bay (42°39'30", 82°39'00"). Alewives use the canals and marshes of the St. John's Marsh area (42°38'30", 82°39'00") as spawning and nursery grounds (MDNR 1977).

Sand Island (42°39'00", 82°41'30"). In September 1979, hundreds of young-of-the-year were found on the North Channel side of Sand Island, in an area with large beds of aquatic vegetation (Myriophyllum spicatum with some Potamogeton) (Schloesser and M. Werner, pers. comm. 1979).

GIZZARD SHAD

The gizzard shad presumably entered Lake St. Clair from Lake Erie via the Detroit River between 1848 and 1877, when this species was first recorded for Lake Erie and Lake Huron respectively (Miller 1957).

St. John's Marsh (42°38'30", 82°39'00"). Gizzard shad use the canals and marshes of the St. John's Marsh area as spawning and nursery grounds (MDNR 1977).

MOONEYE

The mooneye in Lake St. Clair probably spawns in April and May (Johnson 1951).

LAKE HERRING

In the late 1890s, a small portion of the population in the western basin of Lake Erie migrated to Lake St. Clair to spawn (Rathbun and Wakeham 1897).

LAKE WHITEFISH

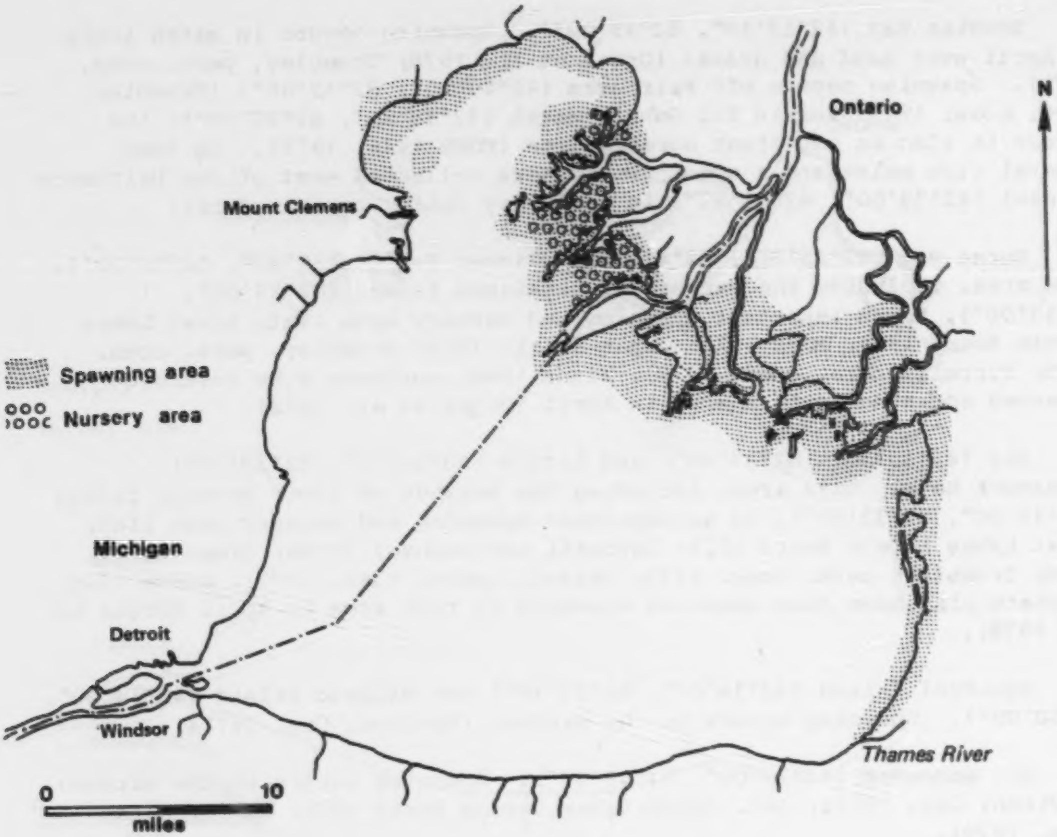
In the late 1800s, Lake St. Clair was well known as a lake whitefish spawning ground (Ward 1897). Historically, spawning runs of lake whitefish, some of which were from Lake Erie, moved up the Detroit River in mid-October to November; large numbers of these fish were caught in Lake St. Clair and in the St. Clair River (Milner 1875; MSBFC 1895; Rathbun and Wakeham 1897; Reighard 1910; Stockwell 1875; Ward 1895a; Wright 1955). By 1910, the run from Lake Erie had disappeared (Reighard 1910). These fish were believed to spawn over large beds of Chara sp. along the western shore of Lake St. Clair near the head of the Detroit River (42°21'00", 82°55'00") (Ward 1895). A few adults were taken in October and November in the area between the head of the Detroit River and Baltimore Bay (42°40'30", 82°43'30") (MSBFC 1895).

RAINBOW SMELT

Rainbow smelt eggs planted in Crystal Lake (44°40', 86°10') (Lake Michigan drainage) in 1912 are believed to be the source of rainbow smelt found in all of the Great Lakes except Lake Ontario. The first record of rainbow smelt in Lake St. Clair was established in 1932; these fish presumably entered the lake via the St. Clair River (Van Oosten 1937a). In 1951-52, spawning runs of rainbow smelt occurred in Lake St. Clair in early April through early May (Van Oosten 1953).

Sand Island (42°39'00", 82°41'30"). In 1979, young-of-the-year were collected at Sand Island during August-October (Schloesser and M. Werner, pers. comm. 1979).

NORTHERN PIKE


Ontario
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Mount Clemens
Spawning area
Nursery area
Michigan
Detroit
Windsor
Thames River
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miles

Northern pike spawn primarily in the sedge "meadows" of the St. Clair Flats (42°35'00", 82°40'00") (FWS 1979d; Jaworski and Raphael 1978a; Trombley, pers. comm. 1979), and also along the east shore of the lake, south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979). There is a pre-spawning migration of northern pike into the marsh areas and a post-spawning migration out of these areas (Trombley, pers. comm. 1979).

Anchor Bay (42°38'00", 82°45'00") (Int. Great Lakes Levels Board 1973; Tyrrell, pers. comm. 1979). Spawning occurs in most nearshore areas between Mt. Clemens (42°35'00", 82°53'00") and St. John's Marsh (42°38'30", 82°39'00") (FWS 1979d) and also in an area (42°37'00", 82°46'00") about 2 mi E of Selfridge Air Force Base at (42°37'00", 82°50'00") (Trombley, pers. comm. 1979).

Salt River (42°39'00", 82°47'00"). In 1979, gravid females were collected at the mouth of the Salt River in late February to early March.

The MDNR reports that the area immediately surrounding the river mouth is a staging area for northern pike that spawn in creeks in the vicinity (Schloesser and M. Werner, pers. comm. 1979).

Bouvier Bay (42°39'30", 82°39'00"). Spawning occurs in marsh areas in April over sand and gravel (Organ et al. 1978; Trombley, pers. comm. 1979). Spawning occurs off Fairhaven (42°40'30", 82°39'00") (Trombley, pers. comm. 1979) and in St. John's Marsh (42°38'30", 82°39'00"); the latter is also an important nursery area (MDNR 1976, 1977). In 1980, several ripe males and a spent female were collected east of the Baltimore Channel (42°39'00", 82°41'30") in early May (GLFL, unpubl. data).

Goose Bay (42°35'00", 82°41'00")--Fisher Bay (42°36'30", 82°39'00"). This area, including the marshes of Dickinson Island (42°37'00", 82°37'00"), is an important spawning and nursery area (Int. Great Lakes Levels Board 1973; MDNR 1975; Organ et al. 1978; Trombley, pers. comm. 1979; Tyrrell, pers. comm. 1979); since 1948, northern pike have been observed spawning in this area in April (Organ et al. 1978).

Big (42°33'30", 82°39'00") and Little (42°34'30", 82°38'00") Muscamoot Bays. This area, including the marshes of lower Harsens Island (42°35'00", 82°35'00"), is an important spawning and nursery area (Int. Great Lakes Levels Board 1973; Jaworski and Raphael 1978a; Organ et al. 1978; Trombley, pers. comm. 1979; Tyrrell, pers. comm. 1979); since 1948, northern pike have been observed spawning in this area in April (Organ et al. 1978).

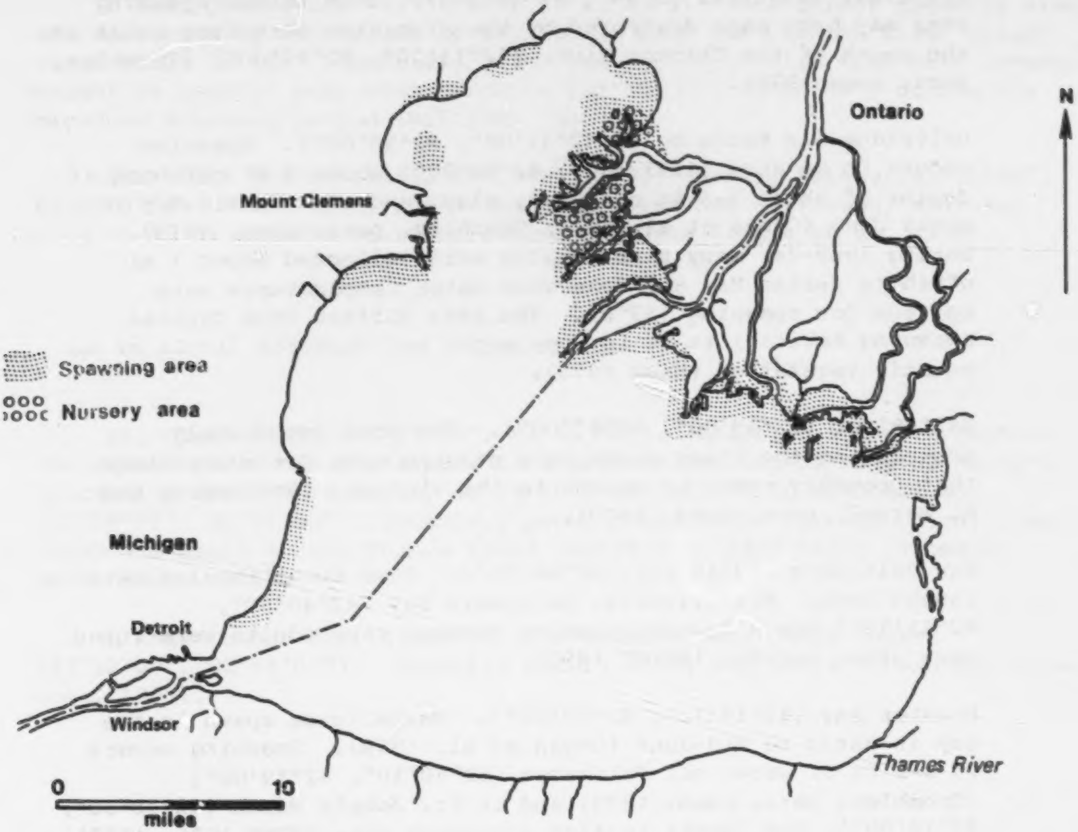
Squirrel Island (42°34'00", 82°33'30") and Walpole Island (42°34'00", 83°30'00"). Spawning occurs in the marshes (Environ. Can. 1977a).

St. Anne Bay (42°29'00", 82°30'00"). Spawning occurs in the marshes (Environ. Can. 1977a; Int. Great Lakes Levels Board 1973; Shain, pers. comm. 1979).

Mitchell Bay (42°28'00", 82°26'00") (Int. Great Lakes Levels Board 1973).

Mitchell Point (42°26'30", 82°26'00") and Tacky Marsh Bay (42°23'00", 82°25'00") (Environ. Can. 1977a).

MUSKELLUNGE



Muskellunge spawn primarily in Anchor Bay (42°38'00", 82°45'00") and in the St. Clair Flats (42°35'00", 82°40'00") area. Tagging studies have indicated that there may be one population on the western side which spawns in the northern areas of the lake and a second population on the eastern side of the lake which probably spawns along the mid-east shore (Haas 1978; Haas and Bryant, undated). Spawning occurs in weed beds at the mouths of streams during the first half of June (Westerman 1959), and is usually completed by the second week in June; in warm years spawning has been completed by mid-May (Williams 1961).

Anchor Bay (42°38'00", 82°45'00"). This is a major spawning area; spawning occurs here in late May to June (Bryant 1975, 1977; Haas 1973; Int. Great Lakes Levels Board 1973; Tyrrell, pers. comm. 1979). Most of the lake population spawns in the southwestern part of the bay (FWS 1979d). Tagging studies indicate rapid southward post-spawning migration into a southwest part of the lake proper, followed by a counter-clockwise movement which brings the adults back to the bay the following spring

(Bryant 1975, 1977; Haas 1973, 1978; Haas and Bryant, undated; Trombley, pers. comm. 1979). Specific spawning areas in Anchor Bay include:

St. Clair Haven (42°35'00", 82°48'00"). This former spawning area may have been destroyed by the diversion structure built at the mouth of the Clinton River (42°35'30", 82°47'00") (Trombley, pers. comm 1979).

Selfridge Air Force Base (42°37'00", 82°50'00"). Spawning occurs in an area (42°37'00", 82°46'00") about 2 mi offshore at depths of about 3-6 ft over mud, clay, and sand in mid-May to early June (Organ et al. 1978; Trombley, pers. comm. 1979). During 1969-74, many ripe females were collected about 1 mi offshore during May and June when water temperatures were optimum for spawning (57°F). The area differs from typical spawning habitat; it is in open water and supports little or no aquatic vegetation (Haas 1978).

Salt River (42°39'00", 82°47'00"). The area immediately surrounding the river mouth is a staging area for muskellunge, that probably spawn in creeks in the vicinity (Schloesser and M. Werner, pers. comm. 1979).

New Baltimore (42°40'30", 82°44'30"). Some spent females were caught here. Historically, Baltimore Bay (42°40'30", 82°43'30") was a famous spawning ground; ripe adults were found here after mid-May (MSBFC 1890).

Bouvier Bay (42°39'30", 82°39'00"). Muskellunge spawn in the bay in early to mid-June (Organ et al. 1978). Spawning occurs in 6-9 ft of water off Fairhaven (42°40'30", 82°39'00") (Trombley, pers. comm. 1979) and in St. John's Marsh (42°38'30", 82°39'00"), the latter is also a nursery area (MDNR 1976, 1977).

St. Clair Flats (42°35'00", 82°40'00"). Ripe fish were commonly caught by anglers during the May-June spawning period (Williams 1961).

Goose Bay (42°35'00", 82°41'00")--Fisher Bay (42°36'30", 82°39'00"). This area, including the marshes of Dickinson Island (42°37'00", 82°37'00"), is an important spawning and nursery area (Int. Great Lakes Levels Board 1973; MDNR 1975; Organ et al. 1978; Trombley, pers. comm. 1979; Tyrrell, pers. comm. 1979).

Big (42°33'30", 82°39'00") and Little (42°34'30", 82°38'00") Muscamoot Bays. Muskellunge spawn in the marshy areas in early to mid-June (Int. Great Lakes Levels Board 1973; Organ et al. 1978; Trombley, pers. comm. 1979; Tyrrell, pers. comm. 1979).

St. Anne Bay (42°29'00", 82°30'00") (Int. Great Lakes Levels Board 1973; Shain, pers. comm. 1979).

Mitchell Bay (42°28'00", 82°26'00) (Int. Great Lakes Levels Board 1973).

L'Anse Creuse Bay (42°34'00", 82°49'30"). This former spawning area was destroyed by the influx of pollutants from the Clinton River cutoff canal built in 1947 (Trombley, pers. comm. 1979). Ripe fish were commonly caught by anglers near Mount Clemens (42°35'00", 82°53'00") during the May-June spawning period (Williams 1961).

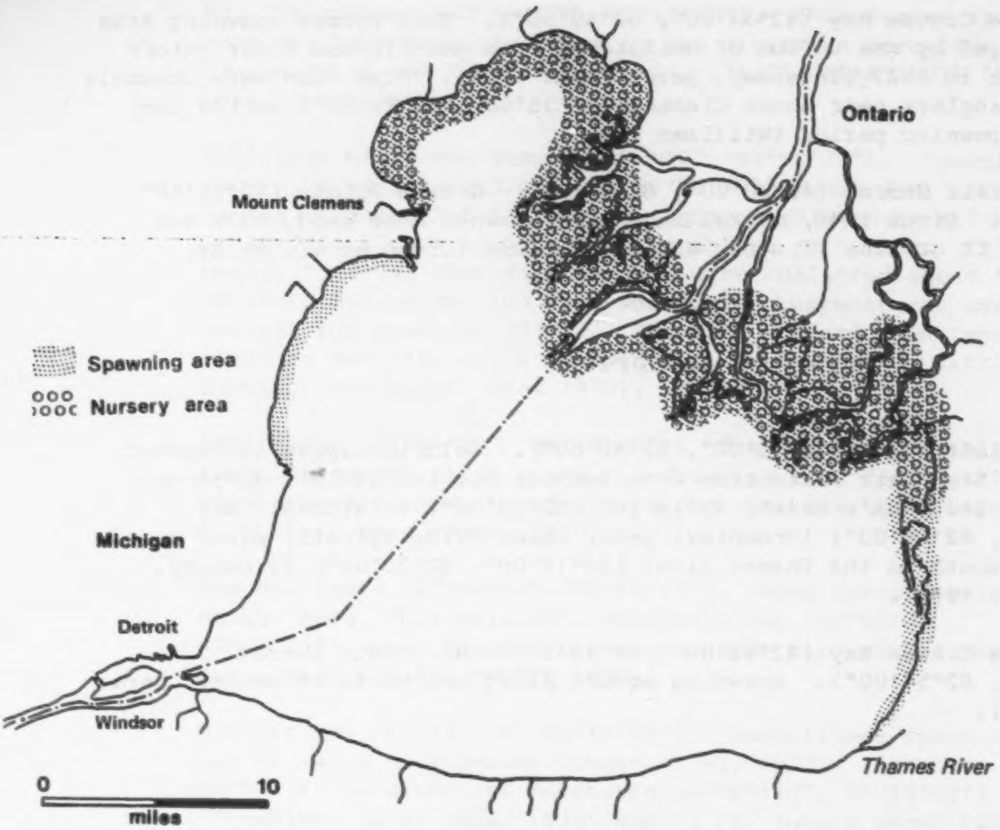
St. Clair Shores (42°30'00", 82°54'00")--Grosse Pointe (42°23'30", 82°53'30"). Since 1948, muskellunge have spawned over sand, mud, and clay in 12 ft or less of water during mid-June (Organ et al. 1978).

GOLDFISH

St. Clair Flats (42°35'00", 82°40'00"). Goldfish spawn throughout the marshy St. Clair Flats area from Bouvier Bay (42°39'30", 82°39'00") (including St. John's Marsh, 42°38'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") (Trombley, pers. comm. 1979; Tyrrell, pers. comm. 1979) and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979).

L'Anse Creuse Bay (42°34'00", 82°49'30")--St. Clair Shores (42°30'00", 82°54'00"). Spawning occurs along sea walls (Trombley, pers. comm. 1979).

CARP



Carp were abundant in Lake St. Clair in the 1880s, and a major commercial carp fishery was established in U.S. waters by 1886 (Cole 1905; Smiley 1886). The origin of these fish is unknown; presumably they originated from plantings made in inland waters of Michigan in the 1880s, or they entered the lake via the Detroit River (McCrimmon 1968). Carp spawn in the shallow marshes throughout the lake (Latta 1954).

Anchor Bay (42°38'00", 82°45'00"). This is an important spawning and nursery area (Int. Great Lakes Levels Board 1973).

St. Clair Flats (42°35'00", 82°40'00"). Carp spawn in the cattail marshes of the St. Clair Flats (Environ. Can. 1977a; Jaworski and Raphael 1978; Latta 1954). Spawning usually occurred in the St. Clair Flats in late May-early June; in the early 1900s, however, spawning was delayed by an influx of cooler than usual water from Lake Huron (Cole 1905). All of the major bays, such as Goose Bay (42°35'00", 82°41'00"), St. Anne Bay (42°29'00", 82°30'00"), Big Muscamoot Bay (42°33'30", 82°39'00"), Mitchell Bay (42°28'00", 82°26'00"), and St. John's Marsh (42°38'30", 82°39'00") are major spawning and nursery areas (Int. Great Lakes Level Board 1973; MDNR 1977). Presently, carp spawn throughout the St. Clair Flats (42°35'00", 82°40'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979; Tyrrell and Shell, pers. comm. 1979).

L'Anse Creuse Bay (42°34'00", 82°49'30")--St. Clair Shores (42°30'00", 82°54'00"). Carp spawn near shore throughout this area (Trombley, pers. comm. 1979).

GOLDEN SHINER

Anchor Bay (42°38'00", 82°45'00"). Spawning occurs north of Belvidere Bay at 42°36'30", 82°47'30" (Trombley, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). Golden shiners spawn throughout the marshy St. Clair Flats area from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979). St. John's Marsh (42°38'30", 82°39'00") in Bouvier Bay is an important spawning and nursery area (MDNR 1977).

EMERALD SHINER

Anchor Bay (42°38'00", 82°45'00"). Spawning occurs north of Belvidere Bay (42°36'00", 82°47'00") at 42°36'30", 82°47'30" (Trombley, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). Emerald shiners spawn in the marshy St. Clair Flats area from Bouvier Bay (42°39'30", 82°39'00"), to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979).

L'Anse Creuse Bay (42°34'00", 82°49'30")--St. Clair Shores (42°30'00", 82°54'00"). Emerald shiners spawn nearshore in this area (Trombley, pers. comm. 1979).

COMMON SHINER

Anchor Bay (42°38'00", 82°45'00"). Spawning occurs north of Belvidere Bay (42°36'00", 82°47'00") at 42°36'30", 82°47'30" (Trombley, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). Common shiners spawn in the marshy St. Clair Flats area from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979).

SPOTTAIL SHINER

Anchor Bay (42°38'00", 82°45'00"). Spawning occurs north of Belvidere Bay (42°36'00", 82°47'00") at 42°36'30", 82°47'30" (Trombley, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). Spawning occurs in the marshy, reedy areas from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979). St. John's Marsh (42°38'30", 82°39'00") in Bouvier Bay is an important spawning and nursery area (MDNR 1977).

Tremblay Creek (42°18'30", 82°31'00"). In 1975, young-of-the-year were collected in a littoral area near the creek over a sandy, gravel bottom in the fall (Suns and Rees 1978).

SPOTFIN SHINER

Anchor Bay (42°38'00", 82°45'00"). Spawning occurs north of Belvidere Bay (42°35'00", 82°47'00") at 42°36'30", 82°47'30" (Trombley, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). Spotfin shiners spawn in the marshy St. Clair Flats area from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979).

BLUNTNOSE MINNOW

St. John's Marsh (42°38'30", 82°39'00"). The canals and marshes of the St. John's Marsh area are spawning and nursery grounds (MDNR 1977).

FATHEAD MINNOW

St. John's Marsh (42°38'30", 82°39'00"). The canals and marshes of the St. John's Marsh area are spawning and nursery grounds (MDNR 1977).

SUCKER spp.

Clinton River (42°35'30", 82°47'00"). In 1979, a spawning run entered the Clinton River in mid-April (UPI 1979).

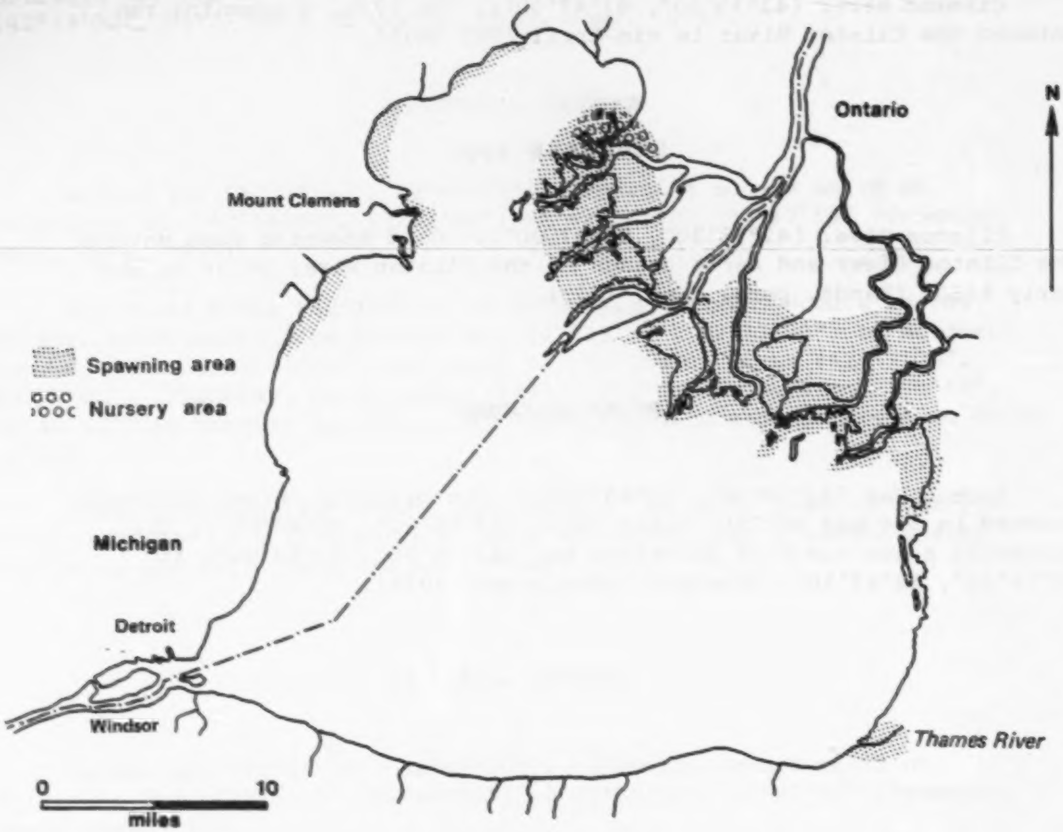
REDHORSE spp.

Clinton River (42°35'30", 82°47'00"). Good spawning runs entered the Clinton River and north branch of the Clinton River prior to the early 1950s (Kandt, pers. comm. 1979).

BROWN BULLHEAD

Anchor Bay (42°38'00", 82°45'00"). Historically, brown bullheads spawned in the bay off St. Clair Haven (42°35'00", 82°48'00"); they presently spawn north of Belvidere Bay (42°36'00", 82°48'00") at 42°36'30", 82°47'30" (Trombley, pers. comm. 1979).

CHANNEL CATFISH


Ontario
N
Mount Clemens
Spawning area
Nursery area
Michigan
Detroit
Windsor
Thames River
0
10
miles

Anchor Bay (42°38'00", 82°45'00"). Spawning occurs in most nearshore areas of the bay (FWS 1979d).

New Baltimore (42°40'30", 82°44'30")--Anchorville (42°41'30", 82°41'30"). Since 1948, spawning has occurred along the shore over clay, sand, and mud (Organ et al. 1978; Trombley, pers. comm. 1979).

Salt River (42°39'00", 82°47'00")--Selfridge Air Force Base (42°37'00", 82°50'00"). Spawning occurs along shore (Trombley, pers. comm. 1979).

Clinton River (42°35'30", 82°47'00"). Spawning occurs at the river mouth (Tyrrell, pers. comm. 1979).

L'Anse Creuse Bay (42°34'00", 82°49'30") (Trombley, pers. comm. 1979). Spawning occurs along shore south for about 3 mi from the Clinton Cutoff Canal (42°33'30", 82°50'30") over clay and sand (Organ et al. 1978).

St. Clair Flats (42°35'00", 82°40'00"). Channel catfish spawn here (Environ. Can. 1977a). The area includes St. John's Marsh (42°38'30", 82°39'00"), which is an important nursery area (MDNR 1977).

Thames River (42°19'00", 82°27'00"). A spawning run occurs here (Shain, pers. comm. 1979).

BULLHEAD spp.

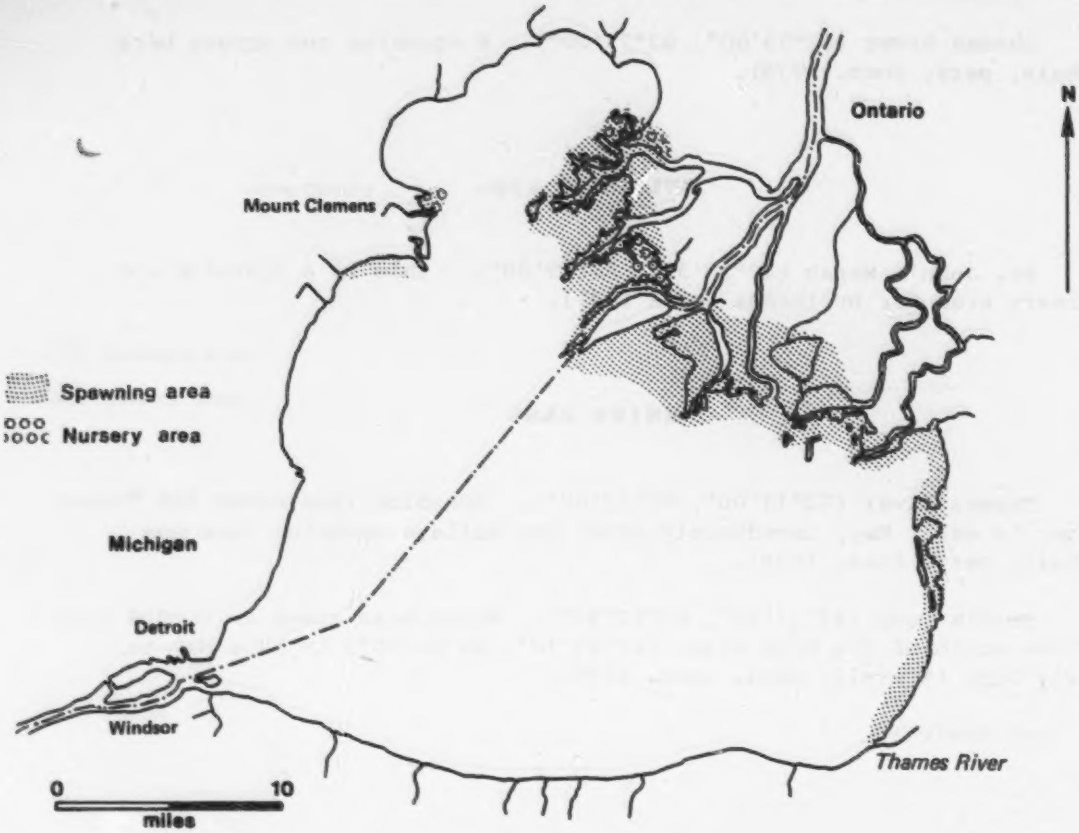
St. John's Marsh (42°38'30", 82°39'00"). This is a spawning and nursery area for bullheads (MDNR 1977).

WHITE BASS

Thames River (42°19'00", 82°27'00"). Spawning runs enter the Thames River in early May, immediately after the walleye spawning runs end (Shain, pers. comm. 1979).

Ford's Cove (42°27'30", 82°52'30"). White bass spawn in Ford's Cove at the mouth of the Milk River (42°27'30", 82°52'30") in late May to early June (Tyrrell, pers. comm. 1979).

ROCK BASS


Mount Clemens
Ontario
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Spawning area
Nursery area
Michigan
Detroit
Windsor
Thames River
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miles

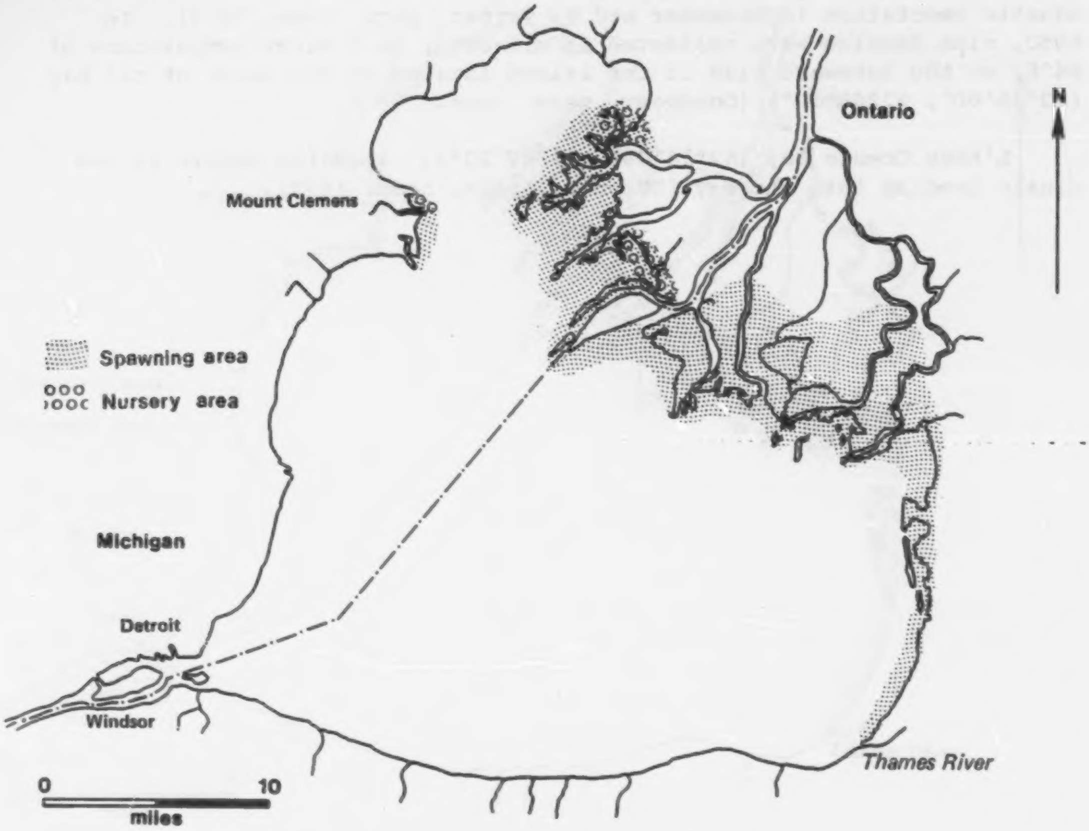
St. Clair Flats (42°35'00", 82°40'00"). Rock bass spawn in vegetated, protected bays and channels primarily in the St. Clair Flats area from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Shain, pers. comm. 1979; Trombley, pers. comm. 1979; Tyrrell, pers. comm. 1979).

> St. John's Marsh (42°38'30", 82°39'00"). This is an important nursery area (MDNR 1977).
>
> Little Muscamoot Bay (42°34'30", 82°38'00"). In 1979, some young-of-the-year (YOY) were collected here over vegetation during the summer (Schloesser and M. Werner, pers. comm. 1979).
>
> St. Anne Bay (42°29'00", 82°30'00") and Goose Lake (42°31'30", 82°31'00"). These are spawning areas (Shain, pers. comm. 1979).

Belvidere Bay (42°36'00", 82°47'00"). Spawning occurs in the canals leading into the bay (Trombley, pers. comm. 1979). In 1979, YOY were collected in the bay from late May through fall in 5-10 ft of water over aquatic vegetation (Schloesser and M. Werner, pers. comm. 1979). In 1980, ripe females were collected in mid-June, at a water temperature of 64°F, on the lakeward side of the island located at the mouth of the bay (42°36'00", 82°46'30") (Goodyear, pers. comm. 1980).

L'Anse Creuse Bay (42°34'00", 82°49'30"). Spawning occurs in the canals leading into the bay (Trombley, pers. comm. 1979).

PUMPKINSEED


Ontario
N
Mount Clemens
Spawning area
Nursery area
Michigan
Detroit
Windsor
Thames River
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miles

St. Clair Flats (42°35'00", 82°40'00"). Pumpkinseeds spawn in the marshy St. Clair Flats area from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979).

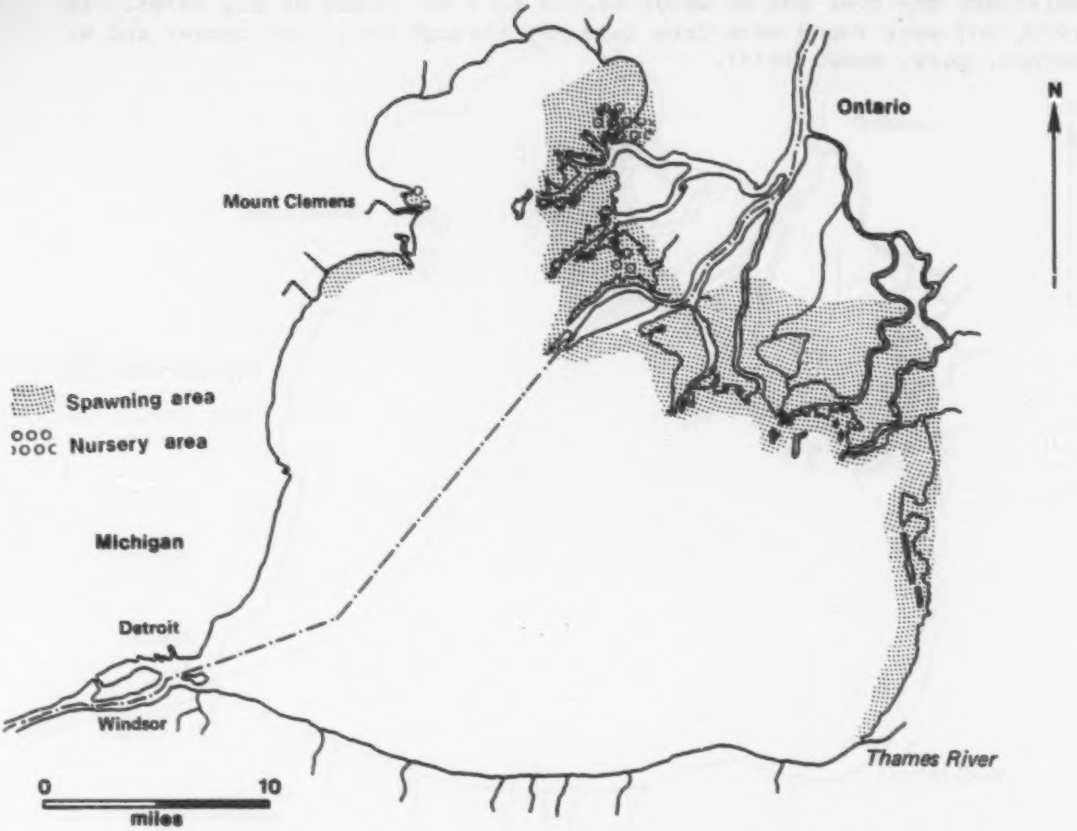
St. John's Marsh (42°38'30", 82°39'00"). This is a spawning and nursery area (MDNR 1977).

Little Muscamoot Bay (42°34'30", 82°38'00"). In 1979, a few young-of-the-year (YOY) were collected in the bay during the summer (Schloesser and M. Werner, pers. comm. 1979).

Goose Lake (42°31'30", 82°31'00") and Mitchell Point (42°26'30", 82°26'00")--St. Luke Club (42°23'00", 82°25'00"). Spawning occurs in these areas (Shain, pers. comm. 1979).

Belvidere Bay (42°36'00", 82°47'00"). Pumpkinseeds spawn in the canals at St. Clair Haven (42°35'00", 82°48'00") and Belvidere Bay (Trombley, pers. comm. 1979). Since 1948, spawning has occurred in Belvidere Bay over mud at water depths to 7 ft (Organ et al. 1978). In 1979, YOY were found here from late May through fall (Schloesser and M. Werner, pers. comm. 1979).

BLUEGILL


Ontario
N
Mount Clemens
Spawning area
Nursery area
Michigan
Detroit
Windsor
Thames River
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miles

St. Clair Flats (42°35'00", 82°40'00"). Bluegills spawn in the St. Clair Flats area; considerable spawning occurs in the cattail marshes (FWS 1979d; Jaworski and Raphael 1978) from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979).

> St. John's Marsh (42°38'30", 82°39'00"). This is a spawning and nursery area (MDNR 1976, 1977).
>
> Bouvier Bay (42°39'30", 82°39'00")--Big Muscamoot Bay (42°33'30", 82°39'00"). Since 1948, bluegills have spawned over sand and gravel in this area (Organ et al. 1978). In 1979, young-of-the-year (YOY) were collected in Little Muscamoot Bay (42°34'30", 82°38'00") during the summer (Schloesser and M. Werner, pers. comm. 1979).

Goose Lake (42°31'30", 82°31'00"), St. Anne Bay (42°29'00", 82°30'00"), Mitchell Bay (42°28'00", 82°26'00"), Mud Bay (42°29'00", 82°26'00"), and Mitchell Point (42°26'30", 82°26'00")--St. Luke Club (42°23'00", 82°25'00"). Spawning occurs in shallow, vegetated areas here (Shain, pers. comm. 1979).

L'Anse Creuse Bay (42°34'00", 82°49'30"). Spawning occurs in the canals in this area (Trombley, pers. comm. 1979).

Belvidere Bay (42°36'00", 82°47'00"). Spawning occurs in the canals in this area (Trombley, pers. comm. 1979) and in the bay over mud bottom (Organ et al. 1978). In 1979, large numbers of YOY were collected in the bay from late May through fall (Schloesser and M. Werner, pers. comm. 1979).

SUNFISH spp.

Unidentified species of sunfish spawn in the St. Clair Flats (42°35'00", 82°40'00") and Anchor Bay (42°38'00", 82°45'00").

Anchor Bay (42°38'00", 82°45'00"). This is a spawning and nursery area (Int. Great Lakes Levels Board 1973). Since 1948, spawning has occurred at New Baltimore (42°40'30", 82°44'30") over mud, clay, and sand (Organ et al. 1978).

St. Clair Flats (42°35'00", 82°40'00"). This is a spawning area for sunfish (Environ. Can. 1977a; FWS 1979d).

Bouvier Bay (42°39'30", 82°39'00"). Since 1948, spawning has occurred here over mud, sand, and gravel (Organ et al. 1978). The St. John's Marsh (42°38'30", 82°39'00") is a spawning and nursery area (MDNR 1976).

Goose Bay (42°35'00", 82°41'00"). This is a spawning and nursery area (Int. Great Lakes Levels Board 1973).

Fisher Bay (42°36'30", 82°39'00"). Spawning occurs over mud (Organ et al. 1978).

Big Muscamoot Bay (42°33'30", 82°39'00"). This is a spawning and nursery area (Int. Great Lakes Levels Board 1973).

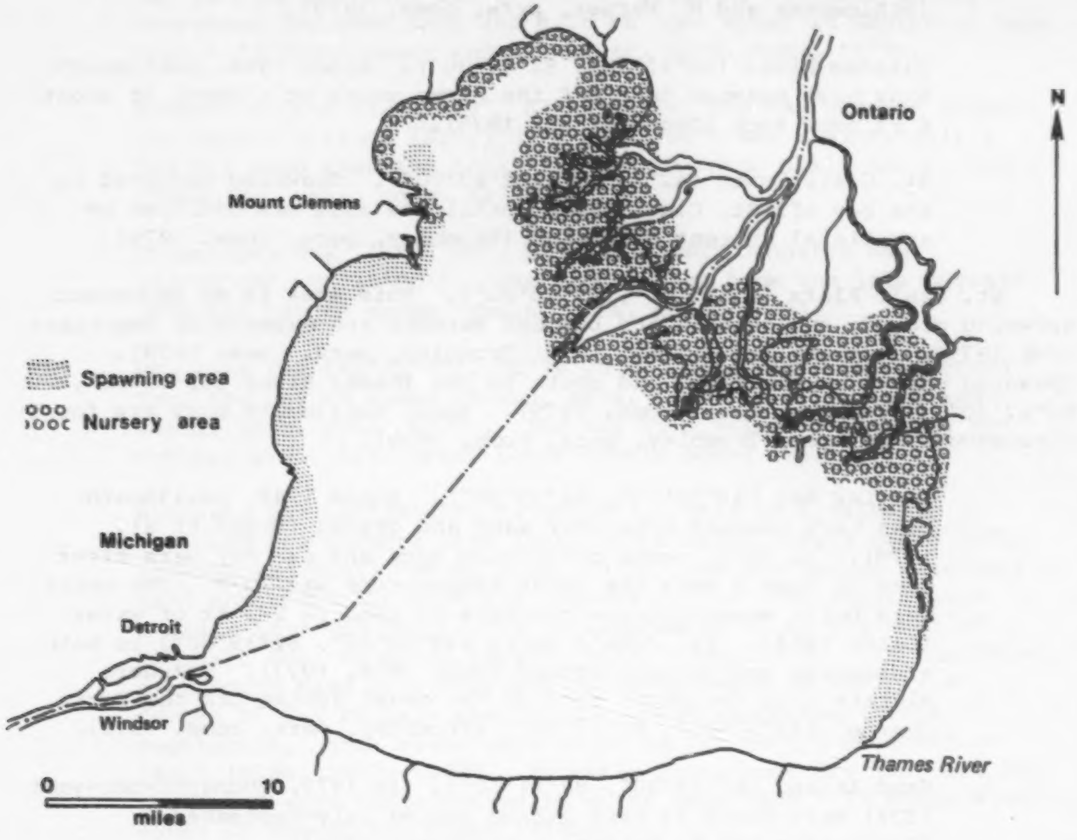
Squirrel Island (42°34'00", 82°33'30") and Walpole Island (42°34'00", 82°30'00"). Spawning occurs in the marshes (Environ. Can. 1977a).

St. Anne Bay (42°29'00", 82°30'00"). The bay and the marshes of St. Anne Island (42°32'00", 82°26'00") are spawning and nursery areas (Environ. Can. 1977a; Int. Great Lakes Levels Board 1973).

Mitchell Bay (42°28'00", 82°26'00"). This is a spawning and nursery area (Int. Great Lakes Levels Board 1973).

Mitchell Point (42°26'30", 82°26'00") and Tacky Marsh Bay (42°23'00", 82°25'00"). These are spawning areas (Environ. Can. 1977a).

SMALLMOUTH BASS


Mount Clemens
Ontario
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▨ Spawning area
ooo Nursery area
Michigan
Detroit
Windsor
Thames River
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miles

Anchor Bay (42°38'00", 82°45'00"). This is a valuable spawning and nursery area (Int. Great Lakes Levels Board 1973; Tyrrell and Shell, pers. comm. 1979), which has an excellent sand substrate for spawning (Korosa 1979). Spawning occurs in early summer. Spent fish subsequently move into deeper areas for the remainder of the summer (Haas 1973), but most travel only a few miles and remain in Anchor Bay (Haas and Bryant, undated).

Selfridge Air Force Base (42°37'00", 82°50'00"). Spawning occurs in an area (42°38'00", 82°46'30"), which lies about 2 mi offshore; at water depths of about 5-8 ft and has a bottom of mud and clay (Organ et al. 1978). Adults tagged at this site have moved as far as the upper St. Clair River, a distance of 30 mi (Bryant 1975). The shoreline from Vase Creek (42°38'30", 82°48'30") south to Belvidere Bay (42°36'00", 82°47'00") has also been used since 1948 (Organ et al. 1978).

Belvidere Bay (42°36'00", 82°47'00"). In 1979, YOY were collected in Belvidere Bay; they were taken first in late July in the middle of the bay, and later at the mouth of the bay (Schloesser and M. Werner, pers. comm. 1979).

Clinton River (42°35'30", 82°47'00"). Since 1948, smallmouth bass have spawned just off the river mouth at a depth of about 6 ft over rock (Organ et al. 1978).

St. Clair Haven (42°35'00", 82°48'00"). Spawning occurred in the bay off St. Clair Haven, until the area was modified by artificial current diversion (Trombley, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). This area is an important spawning ground; the cattail and bulrush marshes are especially important (FWS 1979d; Jaworski and Raphael 1978; Trombley, pers. comm. 1979). Spawning occurs in the Flats and south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979). Young smallmouth bass are found throughout this area (Trombley, pers. comm. 1979).

Bouvier Bay (42°39'30", 82°39'00"). Since 1948, smallmouth bass have spawned here over sand and gravel (Organ et al. 1978). In 1953, nests containing eggs and sac fry were first seen on June 3 when the water temperature was 70°F. The nests were built among Scirpus rootlets in sand in 2-3 ft of water (Latta 1954). St. John's Marsh (42°38'30", 82°39'00") is both a spawning and nursery ground (MDNR 1976, 1977). Spawners migrate into the marsh through the canal system off the North Channel (42°37'00", 82°37'00") (Trombley, pers. comm. 1979).

Sand Island (42°39'00", 82°41'30"). In 1979, young-of-the-year (YOY) were found at Sand Island during July-September (Schloesser and M. Werner, pers. comm. 1979).

Goose Bay (42°35'00", 82°41'00"). This is a valuable spawning and nursery area (Int. Great Lakes Levels Board 1973; Tyrrell and Shell, pers. comm. 1979). In 1953, nests containing live eggs were first found in Long Point Bay (42°35'30", 82°39'00") on June 8, when the water temperature was 64°F, and they were also found along the western shore of the arm separating Long Point Bay from Goose Bay on June 11, when the water temperature was 66-68°F (Latta 1954).

Big (42°33'30", 82°39'00") and Little (42°34'30", 82°38'00") Muscamoot Bays. Big Muscamoot Bay is a valuable spawning and nursery area (Int. Great Lakes Levels Board 1973; Tyrrell and Shell, pers. comm. 1979). In 1953, nests were first seen on the northeast shore of Little Muscamoot on May 31, when the water temperature was 59°F; nesting was completed by June 12. In the Scirpus marsh (42°34'30", 82°38'00") between Big and Little Muscamoot bays, nests with fry were first observed June 11 when the water temperature was 71°F at water depths to 4 ft. Many fry were still over the nests on June 19 (Latta 1954). In 1979, YOY were collected among aquatic vegetation in Little Muscamoot Bay in July-October, but more were found at the head of Big Muscamoot Bay over sand and silt in open water at depths of less than 6 ft (Schloesser and M. Werner, pers. comm. 1979).

Bassett Island (42°31'00", 82°35'00"). The bay between Bassett and Seaway Islands (42°33'00", 82°38'00") was historically a heavily used spawning area; limited spawning still occurs there (Trombley, pers. comm. 1979).

Chematogan Bay (42°30'00", 82°33'30") and Johnston Bay (42°30'00", 82°30'00"). Smallmouth bass from the lake migrate into the bay to spawn (Shain, pers. comm. 1979).

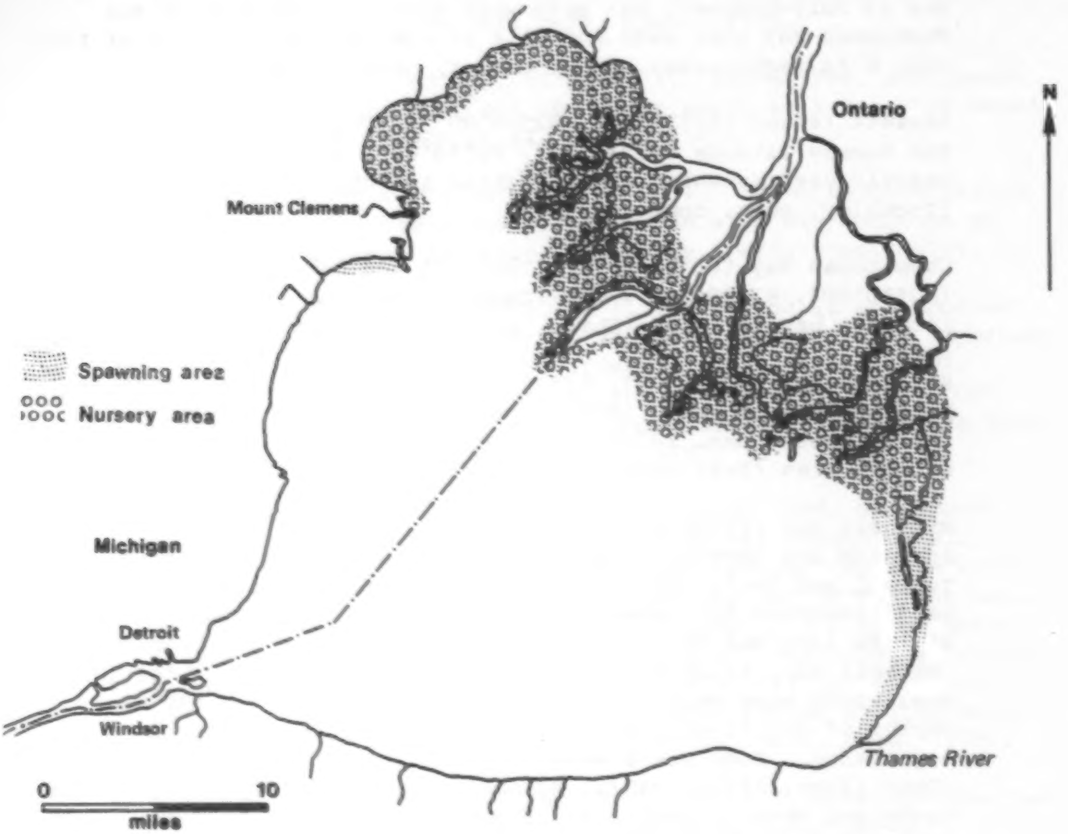
St. Anne Bay (42°29'00", 82°30'00"). Smallmouth bass migrate into the bay to spawn (Shain, pers. comm. 1979; Tyrrell and Shell, pers. comm. 1979). The bay is a valuable spawning and nursery area (Int. Great Lakes Levels Board 1973).

Mitchell Bay (42°28'00", 82°26'00"). This is a valuable spawning and nursery area (Int. Great Lakes Levels Board 1973; Tyrrell and Shell, pers. comm. 1979); the bay has an excellent sand substrate for spawning (Korosa 1979). Smallmouth bass migrate into Mud Bay (42°29'00", 82°26'00"), at the head of Mitchell Bay, to spawn (Shain, pers. comm. 1979). In the 1930s, smallmouth bass were observed building nests in the bay at depths of 2-3 ft on a sand bottom which supported little vegetation. Some nests were built as far as 1/2 mi offshore (Doan 1938b, 1939, 1940). By early July, most fry had left the nests and were concentrated in water less than 3 ft deep, along zones of vegetation (Doan 1938b).

Black Bay (42°26'00", 82°25'30"). Smallmouth bass migrate into the bay to spawn (Shain, pers. comm. 1979).

Point Huron (42°34'00", 82°47'00")--Grosse Pointe Park (42°23'00", 82°54'30"). Historically this shoreline was a major spawning area. In 1947, however, the cutoff canal (42°33'30", 82°50'30") began diverting pollutants into the area. The area south to Eleven Mile Road (42°30'00", 82°52'00") no longer supports spawning but there is still some spawning in the area from the Milk River (42°27'30", 82°52'30") south to Grosse Pointe Park (Trombley, pers. comm. 1979). In 1953, spawning occurred off the St. Clair Shores (42°30'00", 82°54'00") residential district; two partially spent females were caught 500 ft offshore from the foot of Masonic Road (42°30'30", 82°53'00") on June 4 (Latta 1954). Spawning also occurs on the sand banks off Point Huron and to the west of the point along Metropolitan Beach (42°34'00", 82°48'30") (Organ et al. 1978; Trombley, pers. comm. 1979).

LARGEMOUTH BASS


N
Ontario
Mount Clemens
Spawning area
Nursery area
Michigan
Detroit
Windsor
Thames River
0
10
miles

Anchor Bay (42°38'00", 82°45'00"). This is an important spawning and nursery area (Int. Great Lakes Levels Board 1973); spawning occurs in most nearshore areas (FWS 1979d). Since 1948, largemouth bass have spawned over mud in Belvidere Bay (42°36'00", 82°47'00") and along shore north of Belvidere Bay to Vase Creek (42°38'30", 82°48'30") (Organ et al. 1978; Trombley, pers. comm. 1979). In 1979, YOY were collected over aquatic vegetation in the middle of Belvidere Bay after late July and at the bulkhead on the west shore after late August (Schloesser and M. Werner, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). Largemouth bass spawn throughout the St. Clair Flats area, and the cattail marshes are especially good spawning areas (FWS 1979d; Jaworski and Raphael 1978); spawning extends south to the Thames River (42°19'00", 82°27'00") (Trombley, pers. comm. 1979). The inshore area of the Flats is a nursery ground (Trombley, pers. comm. 1979).

Bouvier Bay (42°39'30", 82°39'00"). Since 1948, spawning has occurred here over mud, sand, and gravel out to a depth of about 10 ft (Organ et al. 1978). St. John's Marsh (42°38'30", 82°39'00") is an important spawning and nursery area (Kandt, pers. comm. 1979; MDNR 1976, 1977).

Fisher Bay (42°36'30", 82°39'00"). Spawning occurs over mud (Organ et al. 1978).

Goose Bay (42°35'00", 82°41'00"). This is an important spawning and nursery area (Int. Great Lakes Levels Board 1973; Kandt, pers. comm. 1979; Tyrrell, pers. comm. 1979).

Big Muscamoot Bay (42°33'00", 82°39'00"). This is an important spawning and nursery area (Int. Great Lakes Levels Board 1973). In 1979, a few young-of-the-year (YOY) were collected in open water in the bay at the end of July (Schloesser and M. Werner, pers. comm. 1979).

Little Muscamoot Bay (42°34'30", 82°38'00"). In 1979, a few YOY were collected over aquatic vegetation in about 6 ft of water in July-September (Schloesser and M. Werner, pers. comm. 1979).

Bassett Island (42°31'00", 82°35'00"). The marshes of lower Bassett Island were a major historical spawning area; they still support some reproduction (Trombley, pers. comm. 1979).

Johnston Bay (42°30'00", 82°30'00"). This is a spawning area (Shain, pers. comm. 1979).

St. Anne Island (42°32'00", 82°26'00"). The marshes of the lower island are important spawning and nursery areas (Int. Great Lakes Levels Board 1973; Shain, pers. comm. 1979).

Mitchell Bay (42°28'00", 82°26'00"). This is a spawning and nursery area (Int. Great Lakes Levels Board 1973).

Mitchell Point (42°26'30", 82°26'00")--St. Luke Club (42°23'00", 82°25'00"). Spawning occurs here (Shain, pers. comm. 1979).

L'Anse Creuse Bay (42°34'00", 82°49'30"). Largemouth bass spawn at Metropolitan Beach (42°34'00", 82°48'30") (Kandt, pers. comm. 1979).

BASS spp.

St. Clair Flats (42°35'00", 82°40'00"). The shallow areas, averaging less than 30 ft deep, are important spawning areas for black bass (Environ. Can. 1977a).

Squirrel Island (42°34'00", 82°33'30"). The marshes are important spawning areas (Environ. Can. 1977a).

Walpole Island (42°34'00", 82°30'00"). The marshes are important spawning areas (Environ. Can. 1977a). Historically, Indians fished on bass spawning grounds here (Ont. Game Fish 1911, 1913b).

St. Anne Island (42°32'00", 82°26'00"). The marshes are important spawning areas (Environ. Can. 1977a). Historically, Indians fished on bass spawning grounds on the St. Anne Island Indian Reserve (Ont. Game Fish 1913b).

Mitchell Point (42°26'30", 82°26'00") and Tacky Marsh Bay (42°23'00", 82°25'00"). The marshes in these areas are spawning grounds (Environ. Can. 1977a).

WHITE CRAPPIE

St. Clair Flats (42°35'00", 82°40'00"). White crappie spawn in marsh areas and canals of the St. Clair Flats from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (FWS 1979d; Trombley, pers. comm. 1979).

St. John's Marsh (42°38'30", 82°39'00"). This is a spawning and nursery area (MDNR 1977).

Goose Lake (42°31'30", 82°31'00"). This is a spawning area (Shain, pers. comm. 1979).

Patrick's Cove (42°27'00", 82°25'00"). Spawning occurs in vegetated areas about 4 ft deep (Shain, pers. comm. 1979).

Belvidere Bay (42°36'00", 82°47'00"). Spawning occurs in canals surrounding St. Clair Haven (42°35'00", 82°48'00") and Belvidere Bay (Trombley, pers. comm. 1979) and in Belvidere Bay, proper, over mud bottom (Organ et al. 1978).

BLACK CRAPPIE

Anchor Bay (42°38'00", 82°45'00"). Spawning occurs here in most nearshore areas (FWS 1979d).

Belvidere Bay (42°36'00", 82°47'00"). Spawning occurs in canals surrounding St. Clair Haven (42°35'00", 82°48'00") and Belvidere Bay

(Trombley, pers. comm. 1979) and Belvidere Bay, proper, over mud bottom (Organ et al. 1978).

St. Clair Flats (42°35'00", 82°40'00"). Black crappie spawn in the marsh areas and canals of the St. Clair Flats from Bouvier Bay (42°39'30", 82°39'00") to Mitchell Bay (42°28'00", 82°26'00") and south to the Thames River (42°19'00", 82°27'00") (FWS 1979d; Trombley, pers. comm. 1979).

St. John's Marsh (42°38'30", 82°39'00"). This is a spawning and nursery area (MDNR 1977).

Goose Lake (42°31'30", 82°31'00") and Patrick's Cove (42°27'00", 82°25'00"). Spawning occurs here (Shain, pers. comm. 1979).

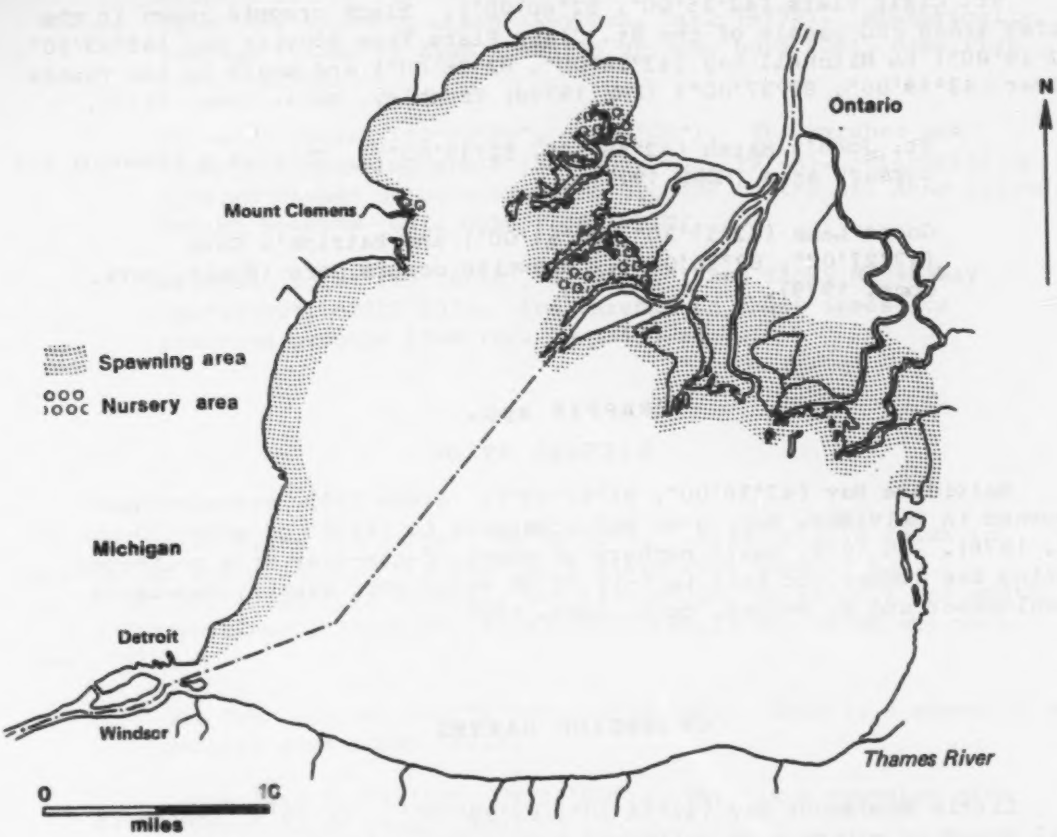
CRAPPIE spp.

Belvidere Bay (42°36'00", 82°47'00"). Since 1948, crappies have spawned in Belvidere Bay, over mud substrate in 1-7 ft of water (Organ et al. 1978). In 1979, small numbers of young-of-the-year were collected during the summer and fall in 5-10 ft of water over aquatic vegetation (Schloesser and M. Werner, pers. comm. 1979).

GREENSIDE DARTER

Little Muscamoot Bay (42°34'30", 82°38'00"). In 1979, adults in full breeding colors were collected during May and June in a vegetated area in Little Muscamoot Bay (Schloesser and M. Werner, pers. comm. 1979).

YELLOW PERCH


Ontario
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Mount Clemens
Spawning area
Nursery area
Michigan
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Windsor
Thames River
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Yellow perch spawn in most inshore areas of Lake St. Clair (Johnston 1977). Runs begin in April, and spawning occurs over sand, gravel, and in marshes (Organ et al. 1978).

Anchor Bay (42°38'00", 82°45'00"). Yellow perch spawn extensively along the shoreline and in the canals on the north side of the bay (Trombley, pers. comm. 1979); spawning occurs in most nearshore areas (FWS 1979d). Since 1948, spawning has occurred along shore from Belvidere Bay (42°36'00", 82°47'00") to Vase Creek (42°38'30", 82°48'30") (Organ et al. 1978). In 1979, gravid and ripe adults were collected off Hall Road (42°38'00", 82°49'00") in 8 ft of water over sand and Chara in April. A few YOY were also found in Belvidere Bay in late fall over aquatic vegetation (Schloesser and M. Werner, pers. comm. 1979). In 1980, males were still running ripe on May 7, and a ripe female was found June 18 when the water temperature was 63°F. Many egg masses were found on gill nets in early May (GLFL, unpubl. data).

St. Clair Flats (42°35'00", 82°40'00"). The littoral areas are important spawning grounds for yellow perch (Environ. Can. 1977a).

Bouvier Bay (42°39'30", 82°39'00")--Big Muscamoot Bay (42°33'30", 82°39'00"). Since 1948, spawning has occurred here over sand, gravel, and vegetation (Organ et al. 1978). St. John's Marsh (42°38'30", 82°39'00") is a spawning and nursery area (MDNR 1976, 1977).

Sand Island (42°39'00", 82°41'30"). In 1980, ripe males were collected around Sand Island as early as April 16 and as late as June 18, at water temperatures of 36° and 55°F, respectively (GLFL, unpubl. data).

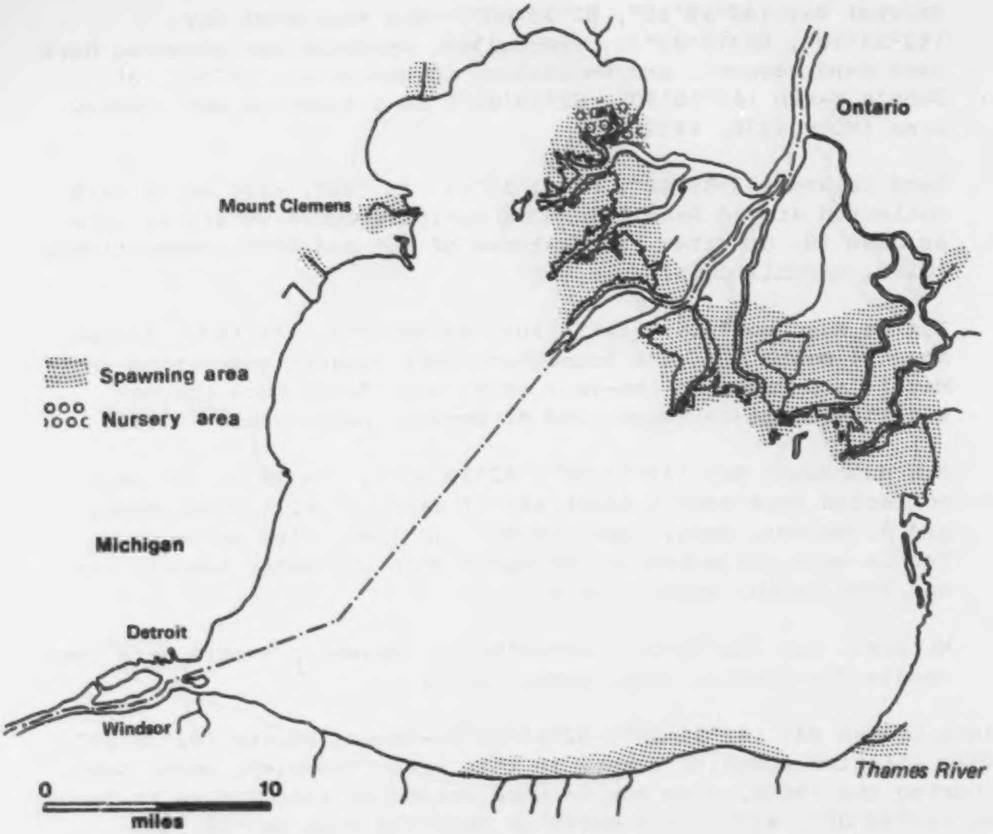
Little Muscamoot Bay (42°34'30", 82°38'00"). In 1979, larvae about 1 month old were found here over aquatic vegetation on May 11 and young-of-the-year (YOY) were found here through mid-November (Schloesser and M. Werner, pers. comm. 1979).

Big Muscamoot Bay (42°33'30", 82°39'00"). In 1979, YOY were collected here over a substrate of sand and silt (Schloesser and M. Werner, pers. comm. 1979). In 1980, ripe males and a female were collected in mid-April when the water temperature was 40°F (GLFL, unpubl. data).

Mitchell Bay (42°28'00", 82°26'00"). Spawning occurs here over vegetation (Shain, pers. comm. 1979).

L'Anse Creuse Bay (42°34'00", 82°49'30")--Grosse Pointe (42°23'30", 82°53'30"). Limited spawning occurs in this area (Trombley, pers. comm. 1979). During the 1960s, ripe adults were collected along shore in Eagle Point Bay (42°29'00", 82°53'00") north of Ten Mile Road (42°28'30", 82°53'00") in St. Clair Shores (42°30'00", 82°54'00"), in approximately 5 ft of water, over sand and vegetation (Moss, pers. comm. 1980).

WALLEYE


N
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Mount Clemens
Spawning area
Nursery area
Michigan
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Windsor
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Historically, walleyes spawned in Lake St. Clair from late March to early May (Rathbun and Wakeham 1897). Lake St. Clair is part of a complex migration route, in which one or several populations of walleyes move freely between the St. Clair-Detroit River system and the western basin of Lake Erie (Applegate and Van Meter 1970; Ferguson 1957). Walleyes tagged in western Lake Erie spawned in Lake St. Clair, and some tagged in Lake St. Clair moved to Lake Erie and spawned in Sandusky Bay (41°29', 82°46') (Regier et al. 1969). A post-spawning migration of walleyes also occurs from the western basin of Lake Erie through Lake St. Clair and the North Channel (42°37'00", 82°37'00") into the St. Clair River and Lake Huron (Olson et al. 1978; Tyrrell, pers. comm. 1979). Young-of-the-year walleyes produced in Lake St. Clair move through the Detroit River into Lake Erie (USBCF 1966; USDI 1967; Ferguson and Derkson 1971; Olson et al. 1978).

Anchor Bay (42°38'00", 82°45'00"). Historically, walleyes spawned in the tributaries to Anchor Bay; large numbers of walleyes were seined at the mouth of the Clinton River (42°35'30", 82°47'00") (MSBFC 1895; Schneider and Leach 1979). Recently, spawning runs have entered the Clinton River and the Salt River (42°39'00", 82°47'00"); it is not yet known if spawning was successful (Trombley, pers. comm. 1979).

St. Clair Flats (42°35'00", 82°40'00"). This is an important spawning area (Environ. Can. 1977a). St. John's Marsh (42°38'30", 82°39'00") is a spawning and nursery area (MDNR 1976, 1977).

Sydenham River (42°33'30", 82°24'30"). A spawning run enters this river, which is a tributary of Chenal Ecart (42°28'30", 82°27'00") (Schneider and Leach 1979; Shain, pers. comm. 1979).

Thames River (42°19'00", 82°27'00"). The Thames River is the major spawning area used historically and presently by walleyes from Lake St. Clair, lower Lake Huron, and the St. Clair River (Environ. Can. 1977a; Ferguson and Cummins 1956; Ferguson and Derkson 1971; Haas and Bryant, undated; Int. Great Lakes Levels Board 1973; Johnston 1977; Rathbun and Wakeham 1897; Schneider and Leach 1977, 1979; Shain, pers. comm. 1979; Spangler et al. 1977; Trombley, pers. comm. 1979); however, the Thames River may be a less important spawning area than the Lake Erie reefs (Applegate and Van Meter 1970; USBCF 1966; USDI 1967). Migrating adults have been collected in the Thames River in early April (Ferguson and Cummins 1956; Nepszy 1977). Walleyes spawn under the ice in February and March and move out of the river by May (Tyrrell, pers. comm. 1979). Since 1877, walleyes from Lake Huron have moved down the St. Clair River to the Thames River to spawn (Regier et al. 1969). Tagging recoveries have indicated that a post-spawning migration occurs from the Thames River back into the St. Clair River and Lake Huron (Ferguson and Derkson 1971; Olson et al. 1978; Spangler et al. 1977); these fish move through the Middle (42°35'00", 82°39'00") and South (42°33'00", 82°39'00") channels to reach the St. Clair River (Tyrrell, pers. comm. 1979). Spent fish may also move from the Thames River to the Detroit River and into Lake Erie (Ferguson and Derkson 1971). Raw sewage pollution may have caused the walleyes to cease spawning in the Thames River near London, Ontario, for a time in the 1950s (Beck 1957 as cited in Johnston 1977).

Stoney Point (42°19'00", 82°33'00"). The area between longitudes 82°30'00" and 82°45'00" is an important spawning area (Environ. Can. 1977a).

Cutoff Canal (42°33'30", 82°50'30"). Spawning runs entered the canal recently, but it is not known if spawning was successful (Trombley, pers. comm. 1979).

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15. Supplementary Notes
This document is one of a set of fourteen volumes.

16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIC cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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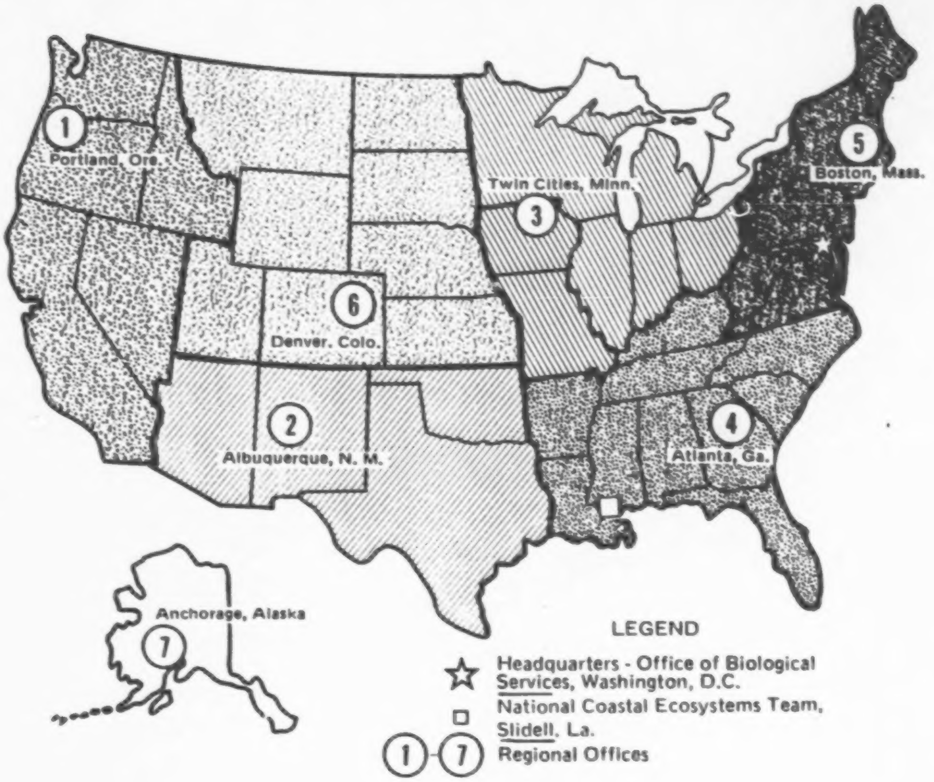

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ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume VIII-Detroit River

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The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

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- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME VIII
Detroit River

by

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Washington, DC 20240

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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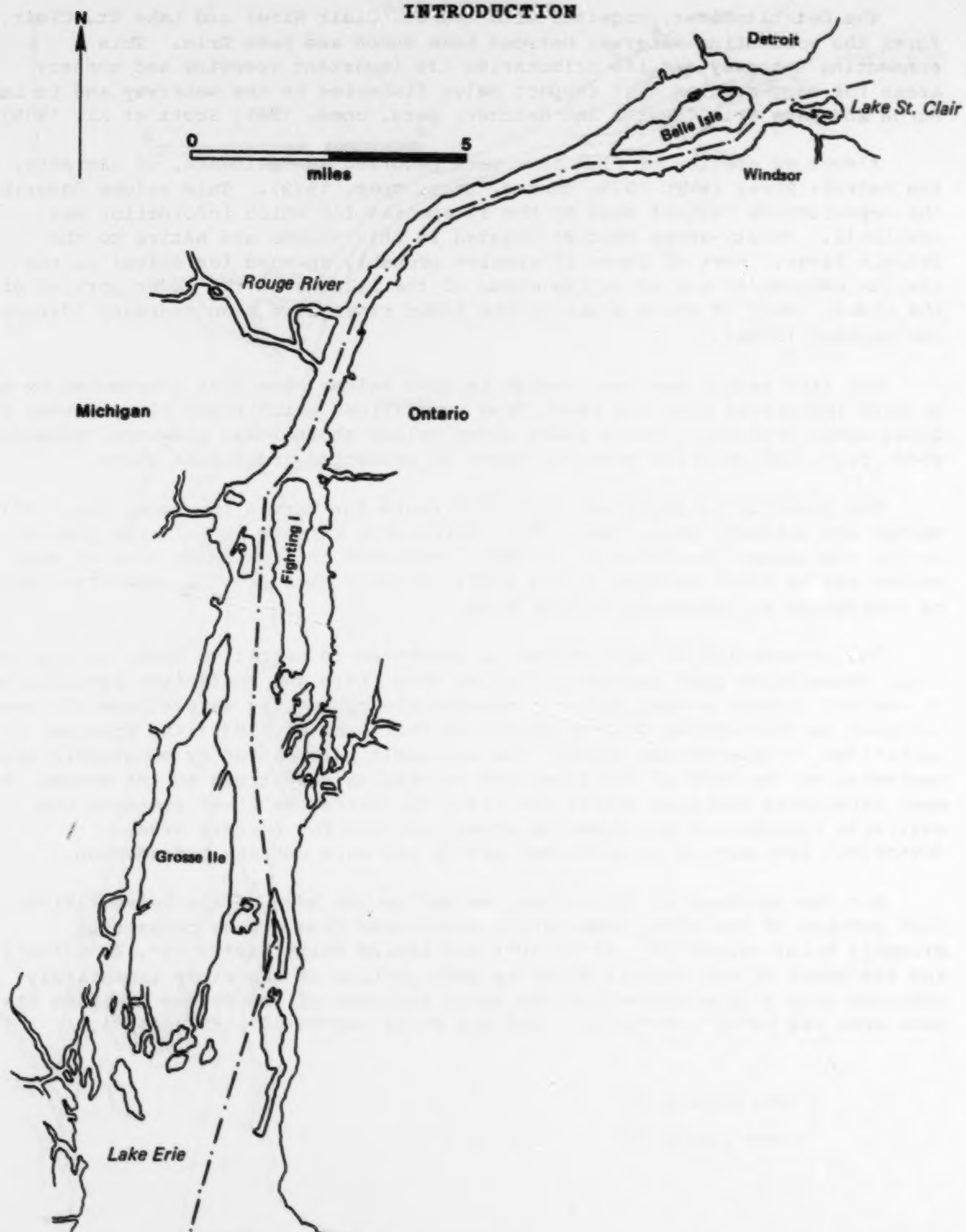
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Lake Erie

The Detroit River, together with the St. Clair River and Lake St. Clair, forms the connecting waterway between Lake Huron and Lake Erie. This connecting waterway and its tributaries are important spawning and nursery areas for many species that support major fisheries in the waterway and in Lake Huron and Lake Erie (Nester and Hatcher, pers. comm. 1981; Scott et al. 1978).

Almost 60 species of fish have been recorded as residents, or migrants, in the Detroit River (MWRC 1975; Thomas, pers. comm. 1979). This volume describes the reproductive habitat used by the 32 species for which information was available. Twenty-seven species treated in this volume are native to the Detroit River. Most of these 27 species probably spawned (or spawn) in the shallow embayments and shoreline areas of the islands in the lower portion of the river. Many of these areas in the lower river have been degraded (Jaworski and Raphael 1978a).

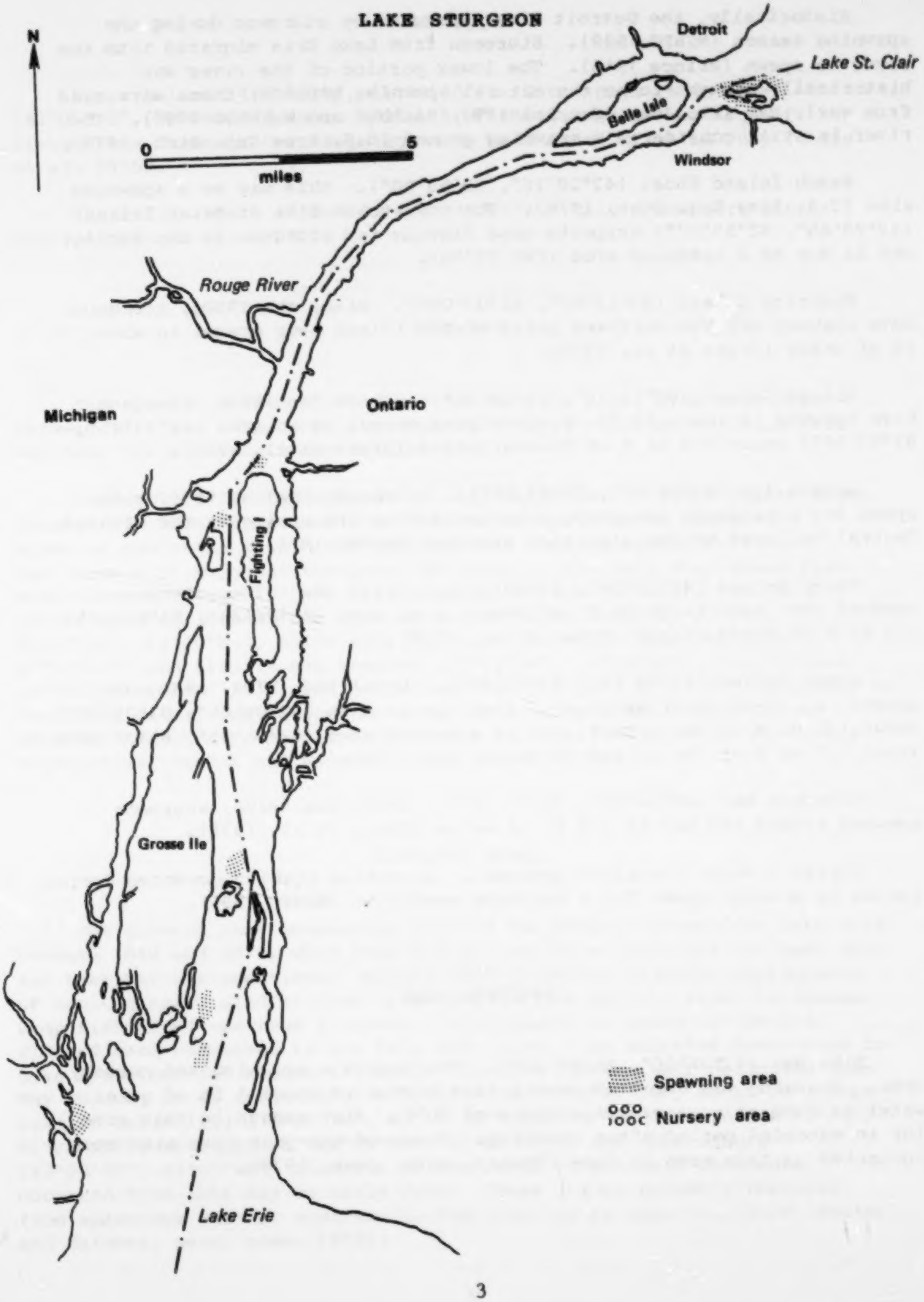
The five exotic species treated in this volume have been introduced by man or have immigrated into the river from populations established elsewhere in the Great Lakes drainage. Smelt spawn along island shorelines; alewives, gizzard shad, carp, and goldfish probably spawn in protected areas near shore.

The river is an important migration route for larvae (Environ. Can. 1977a; Nester and Hatcher, pers. comm. 1981) which move through it in large numbers during the summer (Scott et al. 1978b). Although the residence time of most larvae may be short because of the swift currents that prevail, the river must be considered an important nursery area.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Because the connecting waters have not been assigned to statistical fishing districts (Smith et al. 1971) the species narratives in this volume present the available information by geographic area beginning at the head of the river and continuing downstream to the mouth. For each referenced location within the river the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

For the purposes of this atlas, we define the head of the Detroit River as that portion of the river immediately downstream from a line connecting Windmill Point (42°21'30", 82°55'30") and Askins Point (42°20'00", 82°53'30"); and the mouth of the Detroit River as that portion of the river immediately upstream from a line connecting the north boundary of the Pointe Mouillee State Game area (42°02'20", 83°11'20") and Bar Point (42°03'00", 83°06'30").

LAKE STURGEON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Lake St. Clair
Belle Isle
Windsor
Rouge River
Michigan
Ontario
Fighting I.
Grosse Ile
Lake Erie
▨ Spawning area
ooo Nursery area

Historically, the Detroit River was used by sturgeon during the spawning season (MSBFC 1899). Sturgeon from Lake Erie migrated into the river to spawn (Prince 1918). The lower portion of the river was historically thought to be the natural spawning grounds; these were used from early May into June (Gunckel 1897; Rathbun and Wakeham 1897). The river is still considered a spawning ground (U.S. Army Eng. Dist. 1979).

Peach Island Shoal (42°20'30", 82°55'00"). This may be a spawning site (U.S. Army Eng. Dist. 1979). The downstream side of Peach Island (42°20'45", 82°55'30") supports good fishing for sturgeon in the spring, and it may be a spawning area (FWS 1979d).

Fighting Island (42°13'00", 83°07'00"). Since the 1950s, sturgeon have spawned off the northern point of the island over gravel in about 30 ft of water (Organ et al. 1978).

Grassy Island (42°13'30", 83°08'00"). Since the 1950s, sturgeon have spawned in about 30 ft of water over gravel in an area (42°13'45", 83°07'55") about 1/4 mi N of Grassy Island (Organ et al. 1978).

Grosse Ile (42°08'00", 83°09'00"). Intensive fishing to provide spawn for a hatchery operation occurred during the spring at the Michigan Central Railroad bridge (location unknown) (MSBFC 1895).

Stony Island (42°07'30", 83°08'00"). Until the 1970s, sturgeon spawned over rock in 10-20 ft of water in an area (42°08'20", 83°07'50") 1/2 mi N of Stony Island (Organ et al. 1978).

Sugar Island (42°05'30", 83°08'40"). Until the 1970s, sturgeon spawned in 10-20 ft of water over rock, in an area (42°06'00", 83°08'35") about 1/2 mi N of the island, and in a second area (42°05'05", 83°08'40") about 1/2 mi S of the island (Organ et al. 1978).

Sturgeon Bar (42°04'05", 83°11'15"). Until the 1930s, sturgeon spawned around the bar in 1-3 ft of water (Organ et al. 1978).

Clarke's Point (location unknown). Intensive fishing occurred during spring to provide spawn for a hatchery operation (MSBFC 1895).

SPOTTED GAR

Elba Bay (42°06'00", 83°09'00"). The bay is a spawning and nursery area. Spawning was observed over a silt bottom in about 1 ft of quiet water in June at a water temperature of 70°F. Fish remain in this area for an extended period after spawning. Young-of-the-year have also been collected in this area in June (Thomas, pers. comm. 1979).

GAR spp.

Sugar Island (42°05'30", 83°08'40"). Gars spawn in an area (42°05'15", 83°08'00") about 1/2 mi E of the island at the edge of Livingstone Channel, over vegetation in 6-10 ft of water in July (Organ et al. 1978).

Milleville Beach (42°02'45", 83°11'15"). Gars spawn here along shore (Organ et al. 1978).

ALEWIFE

The alewife presumably entered the Detroit River from Lake Erie between 1931 and 1933, when alewives were first recorded for Lake Erie and Lake Huron respectively (Miller 1957).

During 1974-75, impingement of adult alewives at power plants along the Detroit River increased when fish moved upstream to spawn; the spawning run began when water temperatures rose to about 46-57°F. Impingement of young-of-the-year increased in the fall when these fish migrated downstream to Lake Erie (Detroit Edison 1976b-e). In 1977, larvae were collected from June to August in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of Belle Isle (42°20'30", 82°58'30") and also in the Trenton (42°12'30", 83°08'30"), Livingstone (42°08'00", 83°07'30"), and Amherstburg (42°08'00", 83°07'10") channels of the lower river; peak abundance occurred on July 5-25. These larvae probably resulted from spawnings in the St. Clair River delta or in its tributaries (Nester and Hatcher, pers. comm. 1979).

GIZZARD SHAD

The gizzard shad presumably entered the Detroit River from Lake Erie between 1848 and 1877, when this species was first recorded for Lake Erie and Lake Huron respectively (Miller 1957). During 1974-75, impingement of adult gizzard shad at power plants along the Detroit River increased when fish moved upstream to spawn. Impingement of young-of-the-year gizzard shad increased in the fall when these fish migrated downstream to Lake Erie (Detroit Edison 1976b-e). In 1977, larvae were collected from May to July in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of Belle Isle (42°20'30", 82°58'30") and in the Trenton (42°12'30", 83°08'30"), Livingstone (42°08'00", 83°07'30"), and Amherstburg (42°08'00", 83°07'10") channels in the lower river; peak abundance occurred from late May to early July. These larvae probably resulted from spawnings farther upstream in the river or in Lake St. Clair (Nester and Hatcher, pers. comm. 1979).

Maple Beach (42°03'15", 83°11'15")--Sturgeon Bar (42°04'05", 83°11'15"). Since the 1940s, gizzard shad have spawned here among aquatic vegetation in 1-4 ft of water within about 1/2 mi of shore (Organ et al. 1978).

LAKE HERRING

Historically, large spawning runs from Lake Erie entered the Detroit River in September; these runs disappeared by the late 1800s or early 1900s due to overfishing and pollution (FWS 1977; MSBFC 1887, 1893, 1895; Smith 1972). A small portion of the population from eastern Lake Erie passed through the Detroit River on its way to spawning grounds in Lake St. Clair (FWS 1977; Rathbun and Wakeham 1897).

LAKE WHITEFISH

Historically, large numbers of lake whitefish migrated from Lake Erie to spawn in the Detroit River (Kerr and Kerr 1860-1898; Milner 1874a; Stockwell 1875a; Wright 1955). Portions of the population from the eastern basin of Lake Erie migrated through the river into Lake St. Clair in late October and early November to spawn; some of these fish probably spawned in the Detroit River (FWS 1977; Rathbun and Wakeham 1897; Ward 1895). The run had almost disappeared by the early 1900s (Smith 1969, 1972; Trautman 1957), although a run from Lake Erie still entered the Detroit River in 1910 (Reighard 1910). In 1836-37, half of the catch of lake whitefish from the Great Lakes was made in the Detroit River (MSBFC 1887). Large numbers of migrating fish were caught in seines at Bois Blanc Island (42°05'40", 83°07'15"), Fighting Island (42°13'00", 83°07'00"), Stony Island (42°07'30", 83°08'00"), Grassy Island (42°13'30", 83°08'00"), Mamajuda (42°11'30", 83°08'15"), and Belle Isle (42°20'30", 82°58'30") (Bower 1897; Clark 1910; MSBFC 1887, 1888, 1890, 1893, 1895; Mich. State Comm. Supt. State Fish. 1879; Nevin 1905; Rodd 1914, 1917, 1918). Historical information primarily refers to hatchery operations in which ripe adults were collected and held in pens where they spawned (Nevin 1898; Sterling 1876). The Michigan Fish Commission's center for spawn collection was moved to the Detroit River opposite Belle Isle in 1892 (Langlois 1941).

The migration usually followed the same course among the islands year after year (Milner 1874a). In some years, runs started as early as the last week in September (Milner 1874a). Runs usually began in mid-October and lasted 3-5 weeks (Bower 1897; MSBFC 1893, 1895; Ont. Game Fish 1912, 1917). Eggs were collected as early as October 31 and as late as December 16; peak spawning occurred between November 8 and December 1 (Bissell 1890; Bower 1897; Milner 1874a; MSBFC 1890). In 1896, eggs were last taken from ripe fish on December 16 at Grassy Island and on December 12 at Belle Isle. Hatching began on March 25 and was completed by April

18 (Bower 1897). Spawning occurred along the "channel banks" (MSBFC 1887) and at the mouth of the river (Gunckel 1892), but no specific sites were identified.

Belle Isle (42°20'30", 82°58'30"). In 1977, a few lake whitefish larvae were collected in late April in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island (Nester and Hatcher, pers. comm. 1979).

Grassy Island (42°13'30", 83°08'00"). Larvae were found here in April within 5-6 in. of the surface (Milner 1874a).

Livingstone Channel (42°08'00", 83°07'30"). In 1977, a few larvae were collected here in mid-April (Nester and Hatcher, pers. comm. 1979).

LAKE TROUT

Historically, large spawning runs of lake trout entered the Detroit River, but these runs disappeared by the early 1900s (Smith 1972).

RAINBOW SMELT

Rainbow smelt eggs planted in Crystal Lake (44°40'00", 86°10'00") (Lake Michigan drainage) in 1912, are believed to be the source of smelt found in all of the Great Lakes except Lake Ontario. Rainbow smelt presumably entered the Detroit River from Lake St. Clair between 1932 and 1935, when this species was first recorded for Lake St. Clair and Lake Erie respectively (Van Oosten 1937a). Large spawning runs of smelt occur in the river during April (FWS 1977).

Belle Isle (42°20'30", 82°58'30"). Young-of-the-year smelt have been collected in an area (42°20'30", 82°57'00") near the eastern end of Belle Isle. In 1974-75, larvae were entrained by the Conners Creek Power Plant (42°21'15", 82°57'30") from April to September; peak entrainment occurred in mid-July (Detroit Edison 1976b). In 1977, larvae were collected from May to July just east of (42°21'14", 82°57'00"--42°20'30", 82°56'50") just east of the island; peak abundance occurred May 31 to June 6 (Nester and Hatcher, pers. comm. 1979).

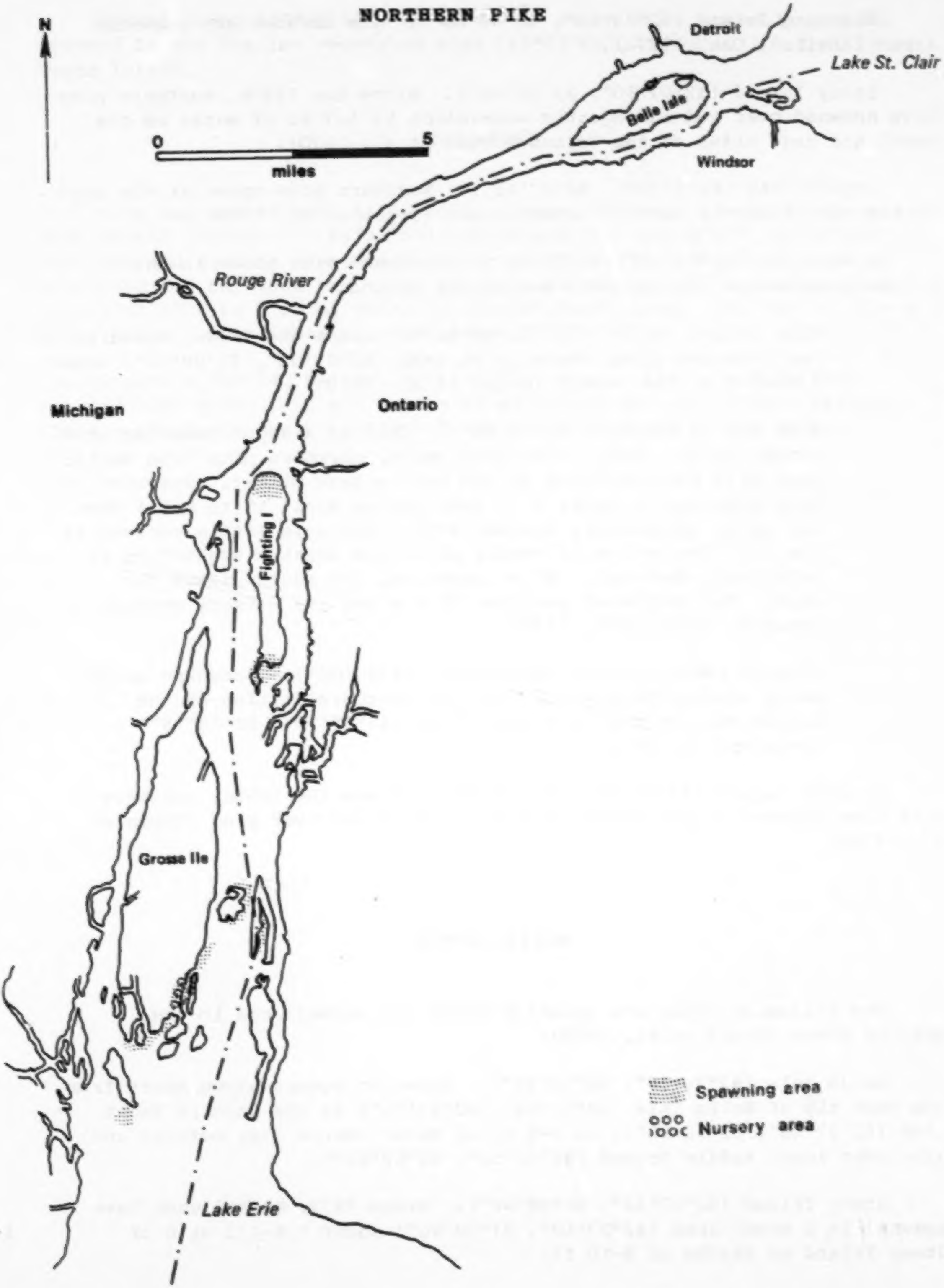
Delray Power Plant (42°17'30", 83°06'00") and River Rouge Power Plant (42°16'30", 83°06'30"). In 1974 and 1975, impingement of adults increased in the spring when spawning runs entered the river, perhaps from Lake Erie. Smelt eggs were found in entrainment samples taken at both plants in late March through May, and larvae were collected from late April to September; peak abundance occurred in July (Detroit Edison 1976c,d).

Trenton Channel (42°12'30", 83°08'30"). In 1977, larvae were collected in the Trenton Channel at the north end of Grosse Ile from May to July; peak abundance occurred May 16 to June 6 (Nester and Hatcher, pers. comm. 1979). In 1974-75, larvae were collected in entrainment samples at the Trenton Channel Power Plant (42°07'20", 83°11'00") from late May to early September; peak entrainment occurred in mid-July (Detroit Edison 1976e).

Stony Island (42°07'30", 83°08'00"). In 1977, larvae were collected in the Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") channels from early May to late June; peak abundance occurred in the second week of May (Nester and Hatcher, pers. comm. 1979).

Sugar Island (42°05'30", 83°08'40"). The rock and sand area around the northern end of the island is used for spawning (Organ et al. 1978). Smelt have spawned here since their introduction into the river, and it is the major spawning area in the river. Ripe adults have been collected here over sandy bottom from April 15 to May 1. Spawning occurs in swift water 2-4 ft deep at water temperatures of about 44°F. Adults disperse immediately after spawning (Thomas, pers. comm. 1979).

NORTHERN PIKE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Rouge River
Michigan
Ontario
Fighting I
Grosse Ile
Spawning area
Nursery area
Lake Erie

Fighting Island (42°13'00", 83°07'00"). The marshes are spawning areas (Environ. Can. 1977a).

Stony Island (42°07'30", 83°08'00"). Since the 1950s, northern pike have spawned over mud and aquatic vegetation in 1-7 ft of water on the north and east sides of the island (Organ et al. 1978).

Crystal Bay (42°07'00", 83°07'15"). Northern pike spawn at the head of the bay, directly east of Stony Island (Organ et al. 1978).

Grosse Ile (42°08'00", 83°09'00"). Northern pike spawn in the following areas at the southern end of the island:

> Elba Island (42°06'10", 83°08'50"). Since the 1950s, spawning has occurred along shore in an area (42°07'00", 83°08'30") about 1/2 mi N of the island (Organ et al. 1978).
>
> Elba Bay (42°06'00", 83°09'00"). This is a major spawning area (Organ et al. 1978). For many years, northern pike from western Lake Erie have migrated to the bay in late winter. Spawning has been observed in water 5 ft deep during April 15 to May 1 when the water temperature reached 40°F. There is little current in the bay; the bottom is mostly silt, and aquatic vegetation is relatively abundant. After spawning, the adults leave the area. The vegetated portions of the bay are nursery grounds (Thomas, pers. comm. 1979).
>
> Hickory (Meso) Island (42°05'30", 83°09'00"). Spawning occurs among aquatic vegetation from the northern portion of the island west to the Ford Yacht Club (42°05'30", 83°10'15") (Organ et al. 1978).

Celeron Island (42°04'45", 83°10'30"). Since the 1950s, northern pike have spawned at the southern tip of the island over sand (Organ et al. 1978).

MUSKELLUNGE

The following areas are spawning sites for muskellunge in the Detroit River (Organ et al. 1978):

Belle Isle (42°20'30", 82°58'30"). Spawning occurs along shore from the east tip of Belle Isle (42°21'00", 82°57'15") to the Detroit Yacht Club (42°21'00", 82°58'30"), in 1-6 ft of water over a clay bottom, and also over Scott Middle Ground (42°20'50", 82°59'05").

Stony Island (42°07'30", 83°08'00"). Since 1973, muskellunge have spawned in a weedy area (42°07'10", 83°08'00") about 1/4-1/2 mi S of Stony Island at depths of 5-10 ft.

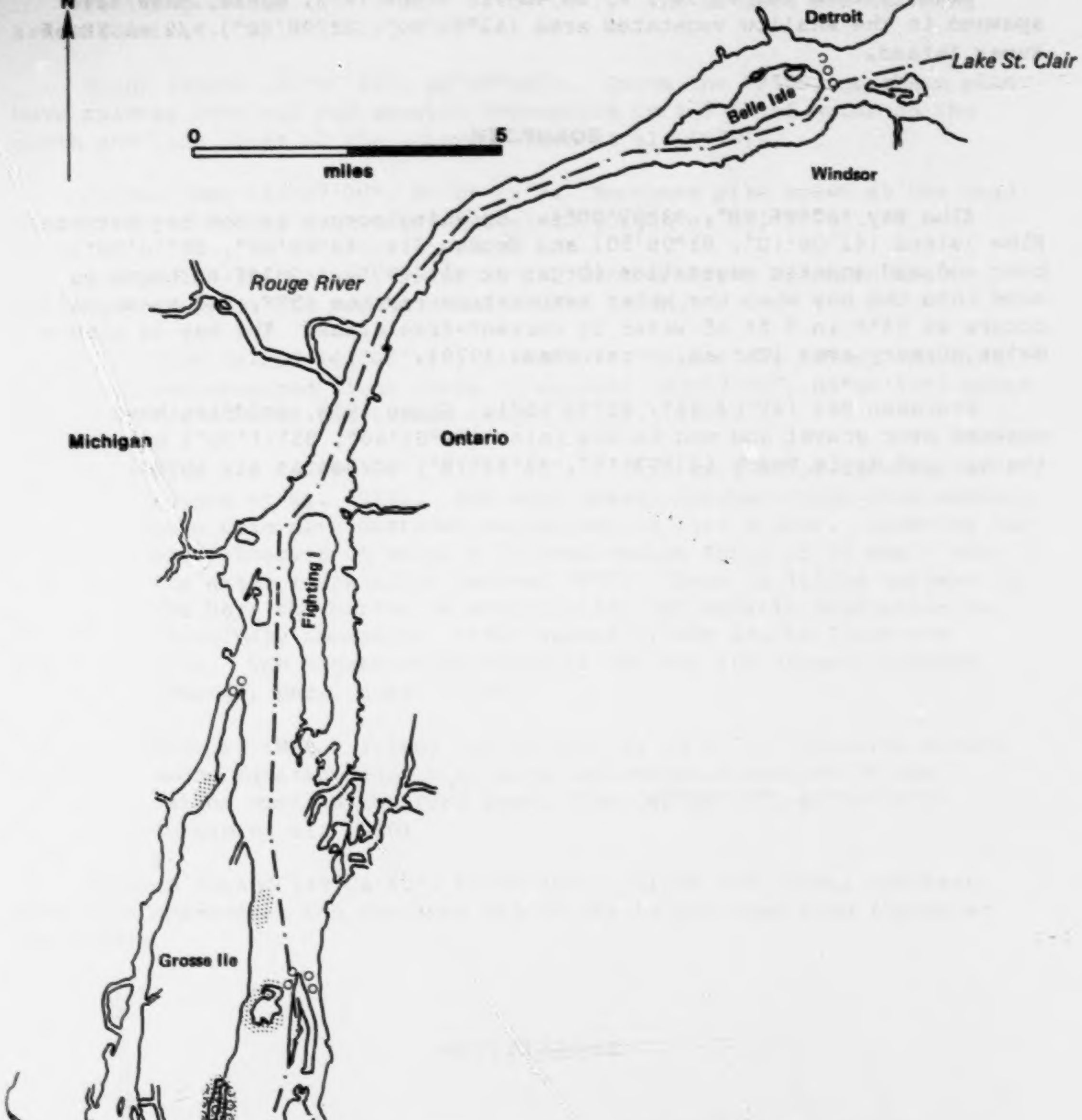
Sugar Island (42°05'30", 83°08'40"). Since 1973, muskellunge have spawned in the shallow vegetated area (42°05'00", 83°08'30") 1/2 mi SE of Sugar Island.

GOLDFISH

Elba Bay (42°06'00", 83°09'00"). Spawning occurs in the bay between Elba Island (42°06'10", 83°08'50) and Grosse Ile (42°08'00", 83°10'00") over mud and aquatic vegetation (Organ et al. 1978). Goldfish begin to move into the bay when the water temperature reaches 45°F, and spawning occurs at 55°F in 5 ft of water in current-free areas. The bay is also a major nursery area (Thomas, pers. comm. 1979).

Sturgeon Bar (42°04'05", 83°11'15"). Since 1936, goldfish have spawned over gravel and mud in the inlet (42°02'40", 83°11'20") between the bar and Maple Beach (42°03'15", 83°11'15") (Organ et al. 1978).

CARP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Fighting I
Grosse Ile
Lake Erie
▨ Spawning area
ooo Nursery area

Prior to 1900, substantial populations of carp were established in the Detroit River. The origin of these fish is unknown; presumably they originated from populations that had become established in Lake St. Clair or Lake Erie (McCrimmon 1968). Spawning generally occurs during May to July among vegetation in water less than about 3 ft deep (Organ et al. 1978).

Belle Isle (42°20'30", 82°58'30"). In 1977, carp larvae were found in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island from late May to mid-July; peak abundance ocurred in late June (Nester and Hatcher, pers. comm. 1979).

Grosse Ile (42°08'00", 83°10'00") (Organ et al. 1978, unless noted otherwise).

> Bridge Road (42°10'20", 83°09'20"). Carp spawn in the mud bottomed marshes on the northwestern shore of the island in an area (42°10'40", 83°09'15"--42°10'00", 83°09'40") extending about 1/4 mi N and S of the bridge.
>
> Thorofare Canal (42°10'10", 83°08'30"). Carp spawn over mud and vegetation in a small area (42°09'10", 83°08'15") on the east shore about 1 mi S of the east outlet of the canal.
>
> Elba Bay (42°06'00", 83°09'00"). Carp spawn over mud and vegetation in the bay and inlets between Elba Island (42°06'10", 83°08'50") and Grosse Ile (42°08'00", 83°09'00") (Organ et al. 1978). Carp begin to migrate to Elba Bay when the temperature of the water reaches about 45°F. Spawning takes place over a silt bottom in 5 ft of water with very little current, at a water temperature of 55°F. The bay is also a major nursery area (Thomas, pers. comm. 1979).
>
> Hickory (Meso) Island (42°05'30", 83°09'00"). Carp spawn over mud in the bay area northwest of the island.

Stony Island (42°07'30", 83°08'00"). Since the 1950s, carp have spawned around the island over mud and aquatic vegetation (Organ et al. 1978).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. In 1977, carp larvae were collected from late May to early July; peak abundance occurred at the end of May (Nester and Hatcher, pers. comm. 1979).

Trenton Channel (42°12'30", 83°08'30"). In 1977, carp larvae were collected from late May to mid-July; peak abundance occurred at the end of May (Nester and Hatcher, pers. comm. 1979).

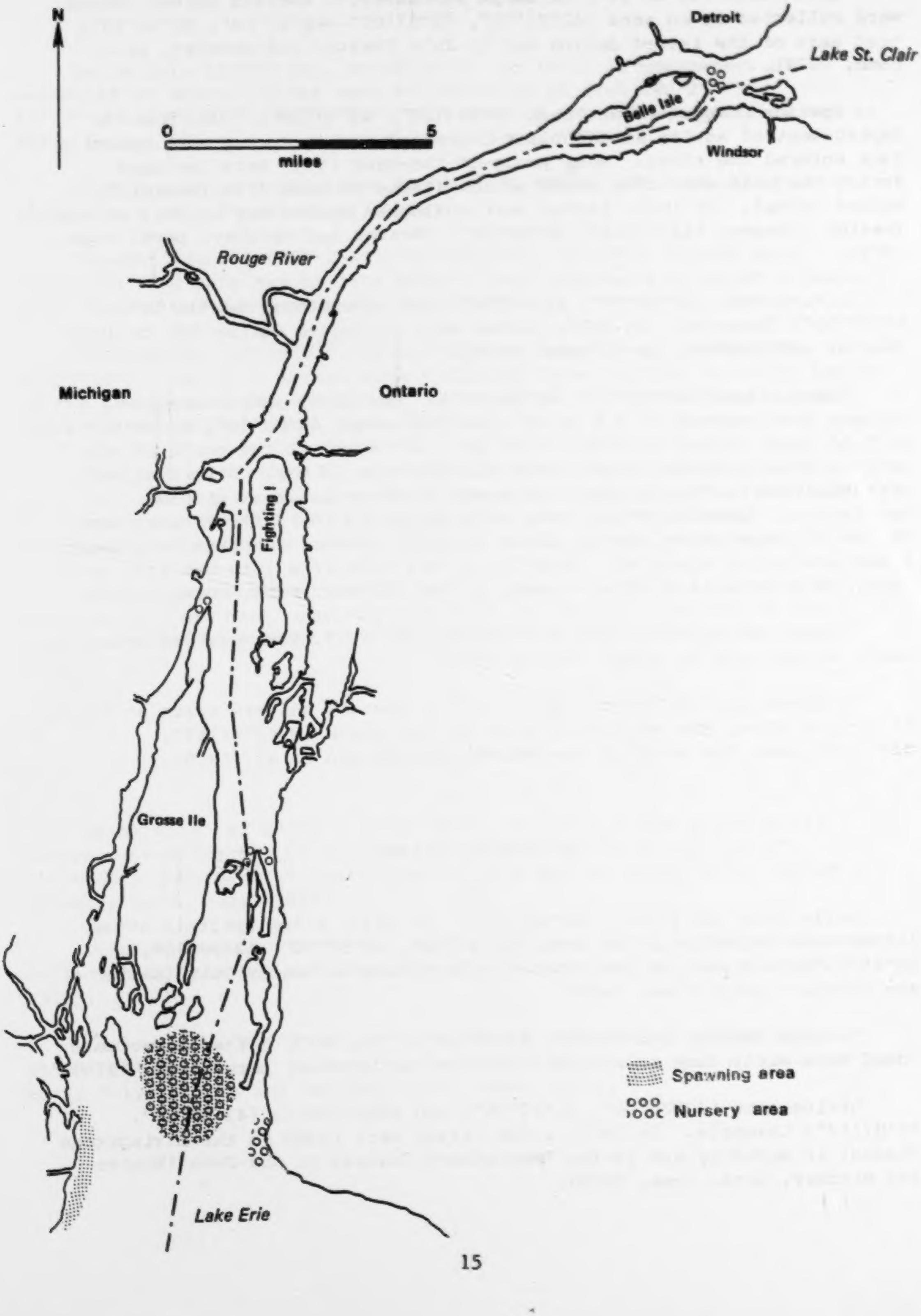
Celeron Island (42°04'45", 83°10'30"). Since the 1920s, carp have spawned over mud in a small area along the southern tip of the island in 5-6 ft of water; they also spawn over mud in the small lake in the center of the island (Organ et al. 1978).

Brownstown Creek (42°05'00", 83°12'00"). Since the 1920s, carp have spawned over mud at the mouth of the creek (Organ et al. 1978).

Sturgeon Bar (42°04'05", 83°11'15"). Since 1936, carp have spawned over gravel and mud in the first inlet (42°04'40", 83°11'20") south of the bar. Since 1920, carp have spawned over mud along the shoreline (42°04'30", 83°11'30") about 1/4 mi N of the bar (Organ et al. 1978).

Milleville Beach (42°02'45", 83°11'15"). During the 1970s, carp spawned in a small area along the shore here in less than 3 ft of water (Organ et al. 1978).

EMERALD SHINER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Windsor
Rouge River
Michigan
Ontario
Fighting I.
Grosse Ile
Spawning area
Nursery area
Lake Erie

Belle Isle (42°20'30", 82°58'30"). In 1977, emerald shiner larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island during May to July (Nester and Hatcher, pers. comm. 1979).

Trenton Channel Power Plant (42°07'20", 83°11'00"). In 1974-75, impingement of adults at the plant increased during spring when spawning runs entered the river. Most young-of-the-year (YOY) were impinged during the fall when they migrated downstream to Lake Erie (Detroit Edison 1976e). In 1977, larvae were collected during May to July in the Trenton Channel (42°12'30", 83°08'30") (Nester and Hatcher, pers. comm. 1979).

Livingstone (42°08'00", 83°07'10") and Amherstburg (42°08'00", 83°07'00") Channels. In 1977, larvae were collected during May to July (Nester and Hatcher, pers. comm. 1979).

Sugar Island (42°05'30", 83°08'40"). For 30-40 years, emerald shiners have spawned in a 4 sq mi area from about 42°04'30", 83°09'00" 1 mi S of Sugar Island to about 42°02'40", 83°08'50" at the mouth of the Detroit River. Adults begin concentrating here in May. Ripe females were observed in fairly clear, slow-moving water in areas with no vegetation. Spawning occurs over sand bottom in 10-12 ft of water when the water temperature reaches about 55-60°F. Adults disperse into nearby areas soon after spawning. Hatching occurs here from late May into early June. This area is a major nursery ground (Thomas, pers. comm. 1979).

Sunset Beach (42°03'20", 83°07'00"). In 1975, YOY were collected in beach seines here in August (Paine 1976).

Sturgeon Bar (42°04'05", 83°11'15"). Emerald shiners spawn at the 6 ft contour along the west shore from the bar south to 42°01'55", 83°11'00" near the mouth of the Huron River (Organ et al. 1978).

SPOTTAIL SHINER

Belle Isle (42°20'30", 82°58'30"). In 1977, a few spottail shiner larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island in late June and early July (Nester and Hatcher, pers. comm. 1979).

Trenton Channel (42°12'30", 83°08'30"). In 1977, a few larvae were found from early June to mid-July (Nester and Hatcher, pers. comm. 1979).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. In 1977, a few larvae were found in the Livingstone Channel in mid-July and in the Amherstburg Channel in mid-June (Nester and Hatcher, pers. comm. 1979).

MINNOW spp.

Belle Isle (42°20'30", 82°58'30"). In 1977, large numbers of unidentified minnow larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island from late May to early August (Nester and Hatcher, pers. comm. 1979).

BASF Wyandotte Corporation (42°13'00", 83°08'30"). Spawning occurs along shore here (Organ et al. 1978).

Trenton Channel (42°12'30", 83°08'30"). In 1977, larvae were collected from late May to late August; peak abundance occurred in early July (Nester and Hatcher, pers. comm. 1979).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10"). In 1977, larvae were collected from late May to early August in the Livingstone Channel and to late July in the Amherstburg Channel (Nester and Hatcher, pers. comm. 1979).

Elba Island (42°06'10", 83°08'50"). Spawning occurs over mud in less than about 5 ft of water along the eastern shore of the island and in an area (42°06'55", 83°07'40") about 1 mi NE of the island, immediately west of Livingstone Channel (Organ et al. 1978).

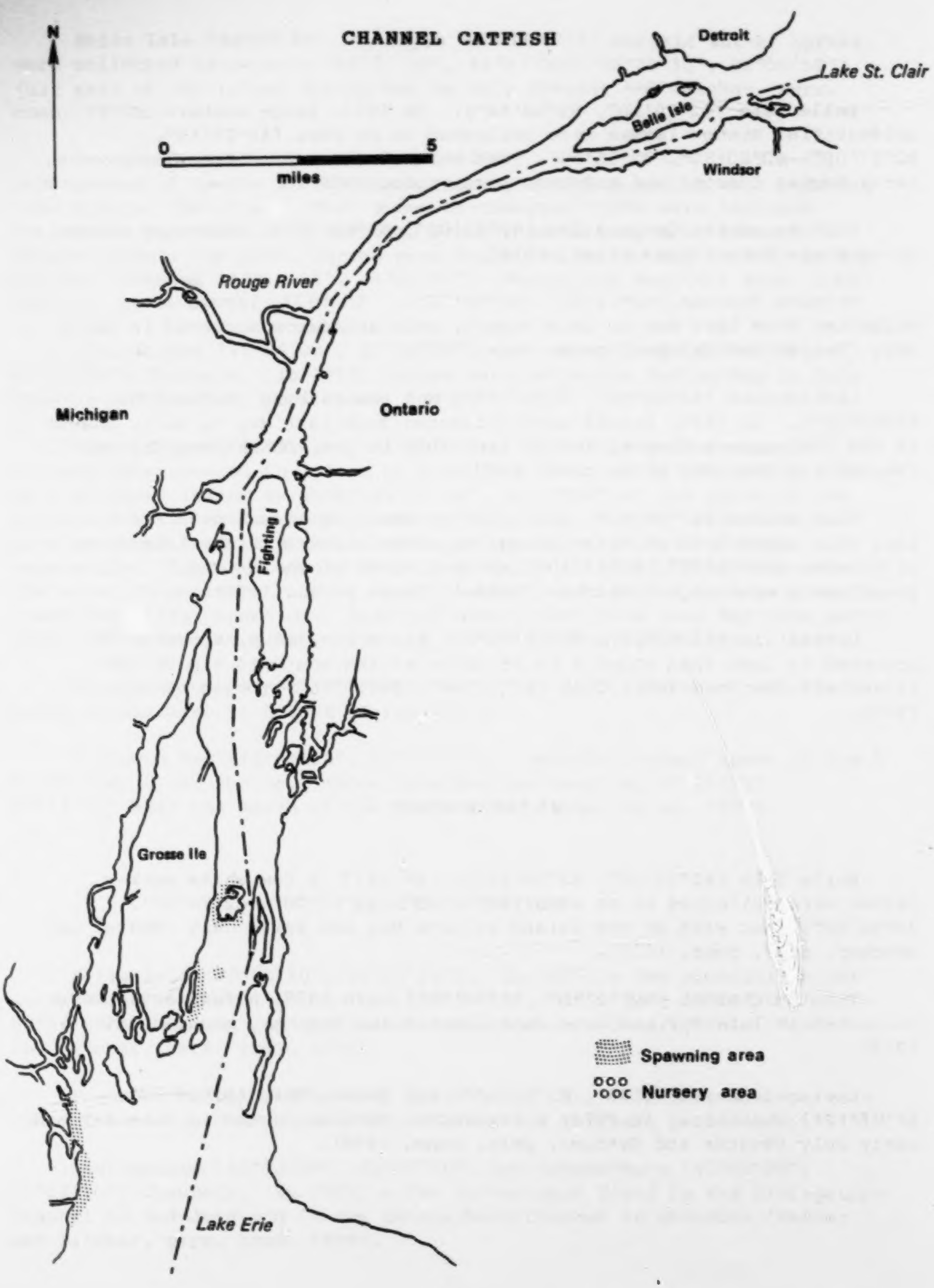
Grosse Ile (42°08'00", 83°10'00"). Since the 1950s, spawning has occurred in less than about 4 ft of water at the southern tip of the island off the Ford Yacht Club (42°05'20", 83°10'15") (Organ et al. 1978).

WHITE SUCKER

Belle Isle (42°20'30", 82°58'30"). In 1977, a few white sucker larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island in late May and early July (Nester and Hatcher, pers. comm. 1979).

Trenton Channel (42°12'30", 83°08'30"). In 1977, a few larvae were collected in late May and late June (Nester and Hatcher, pers. comm. 1979).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. In 1977, a few larvae were collected in late May and early July (Nester and Hatcher, pers. comm. 1979).



CHANNEL CATFISH

N
0
5
miles
Detroit
Lake St. Clair
Belle Isle
Windsor
Rouge River
Michigan
Ontario
Fighting I
Grosse Ile
Lake Erie
Spawning area
Nursery area

Channel catfish spawning areas were identified only in the lower river (Organ et al. 1978):

Stony Island (42°07'30", 83°08'00"). Channel catfish spawn along all but the eastern shore of the island; spawning occurs among aquatic vegetation over mud in 1-3 ft of water.

Elba Island (42°06'10", 83°08'50"). Spawning occurs along the east and north shores of the island.

Fox Island (42°06'20", 83°08'30")--Powderhouse Island (42°06'30", 83°08'10"). Since the 1950s, spawning has occurred between the islands over mud in 6-12 ft of water.

Sturgeon Bar (42°04'05", 83°11'15")--Maple Beach (42°03'15", 83°11'15"). During the 1940s and the 1970s, channel catfish spawned along shore in this area in 1-4 ft of water among vegetation. The absence of catfish in this area during the 1950s and 1960s has been attributed to high water levels, temperature changes, and pollution.

Milleville Beach (42°02'45", 83°11'15"). Since the 1950s, channel catfish have spawned in an area (42°02'40", 83°09'50") about 1 1/4 mi off Milleville Beach over a mud bottom in 10-12 ft of water.

BULLHEAD spp.

Bullhead spawning areas were identified only in the lower river; spawning occurs as early as March (Organ et al. 1978).

Stony Island (42°07'30", 83°08'00"). Bullheads spawn along all but the eastern shoreline of the island; spawning occurs among aquatic vegetation over mud in 1-3 ft of water.

Elba Island (42°06'10", 83°08'50"). Spawning occurs along the east shore of Elba Island over mud.

Grosse Ile (42°08'00", 83°09'00"). Since 1950, bullheads have spawned at the mouth of Frenchman Creek (42°05'30", 83°09'50") and between Hickory (Meso) Island (42°05'30", 83°09'00") and Grosse Ile; spawning occurred on mud in 1-3 ft of water.

Sturgeon Bar (42°04'05", 83°11'15")--Maple Beach (42°03'15", 83°11'15"). In the 1940s and the 1970s, bullheads spawned along this shore among vegetation in 1-4 ft of water. The absence of bullheads in this area during the 1950s and 1960s has been attributed to high water levels, temperature changes, and pollution.

TROUT-PERCH

Belle Isle (42°20'30", 82°58'30"). In 1975, larvae were collected in entrainment samples at the Conners Creek Power Plant (42°21'15", 82°57'30") from late-May to mid-August (Detroit Edison 1976b). In 1977, a few troutperch larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of Belle Isle from early May to mid-July (Nester and Hatcher, pers. comm. 1979).

Delray Power Plant (42°17'30", 83°06'00") and River Rouge Power Plant (42°16'30", 83°06'30"). In 1975, larvae were collected in entrainment samples from late May to mid-July (Detroit Edison 1976c,d).

Trenton Channel (42°12'30", 83°08'30"). In 1977, one larva was collected in late June (Nester and Hatcher, pers. comm. 1979).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. A few larvae were collected in late May and early June (Nester and Hatcher, pers. comm. 1979).

BROOK SILVERSIDE

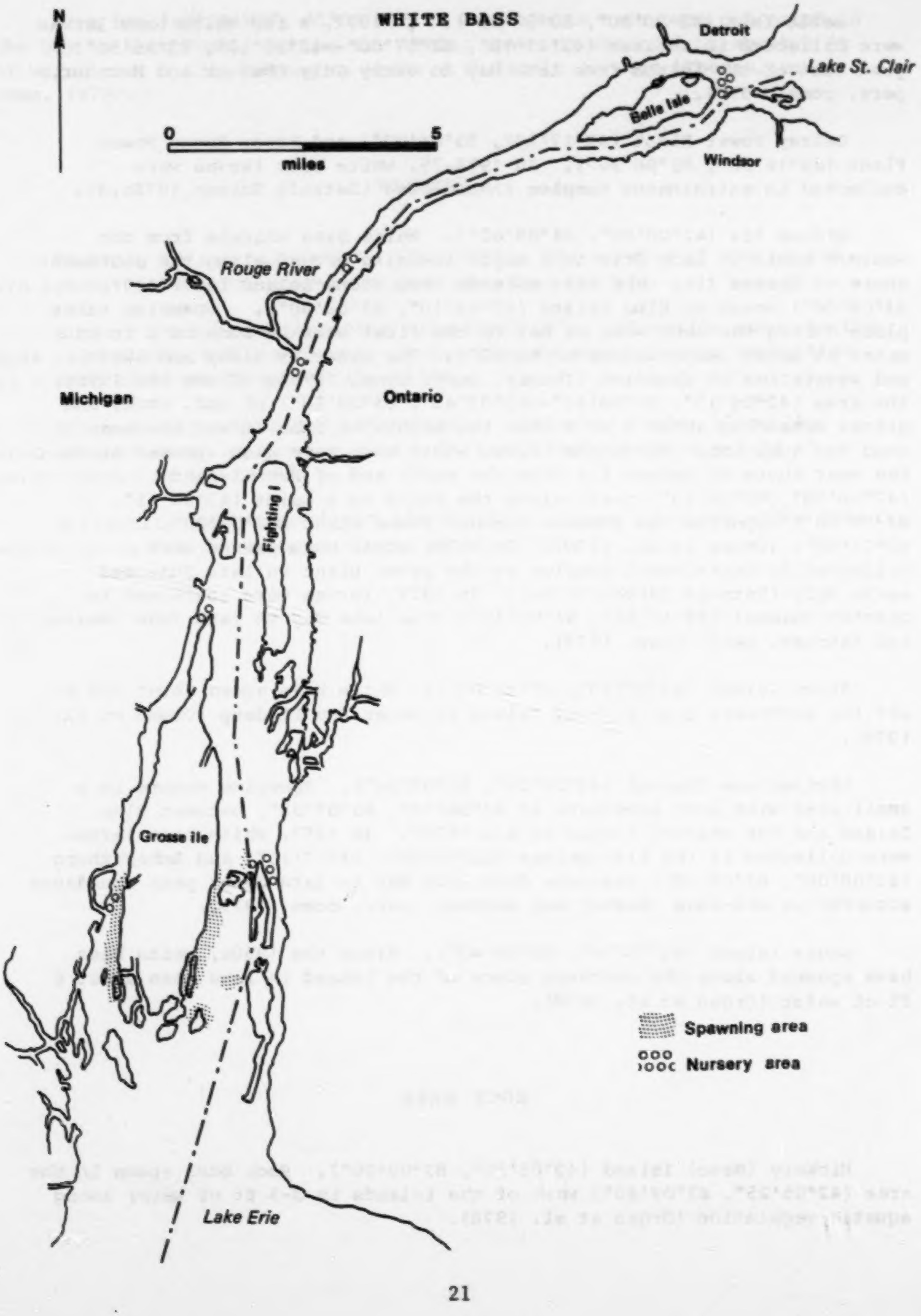
Belle Isle (42°20'30", 82°57'00"). In 1977, a few larvae were collected in July in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island (Nester and Hatcher, pers. comm. 1979).

BURBOT

Belle Isle (42°20'30", 82°58'30"). In 1977, a few burbot larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island from mid-April to early July (Nester and Hatcher, pers. comm. 1979).

Trenton Channel (42°12'30", 83°08'30"). In 1977, one larva was collected in mid-May (Nester and Hatcher, pers. comm. 1979).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. In 1977, a few larvae were collected in early May and early July (Nester and Hatcher, pers. comm. 1979).



WHITE BASS

N
Detroit
Lake St. Clair
Belle Isle
0
5
miles
Windsor
Rouge River
Michigan
Ontario
Fighting I.
Grosse Ile
Lake Erie
Spawning area
Nursery area

Belle Isle (42°20'30", 82°58'30"). In 1977, a few white bass larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island from late May to early July (Nester and Hatcher, pers. comm. 1979).

Delray Power Plant (42°17'30", 83°06'00") and River Rouge Power Plant (42°16'30", 83°06'30"). In 1974-75, white bass larvae were collected in entrainment samples in mid-June (Detroit Edison 1976c,d).

Grosse Ile (42°08'00", 83°09'00"). White bass migrate from the western basin of Lake Erie to a major spawning ground along the southeast shore of Grosse Ile; this area extends from Stony Island (42°07'30", 83°08'00") south to Elba Island (42°06'10", 83°08'50"). Spawning takes place during the last week in May to the first week in June in 8 ft of water at water temperatures of 60-65°F. The water is clear and swift, and vegetation is abundant (Thomas, pers. comm. 1979). Since the 1950s, the area (42°06'15", 83°08'40"--42°07'45", 83°08'20") of mud, rock, and gravel extending about 2 mi N from the middle of Elba Island has been used for spawning. Since the 1920s, white bass have also spawned along the west shore of Grosse Ile from the south end of Swan Island (42°06'00", 83°10'30") north along the shore to a point (42°07'15", 83°10'30") opposite the Trenton Channel Power Plant (42°07'20", 83°11'00") (Organ et al. 1978). In 1975, white bass larvae were collected in entrainment samples at the power plant in late June and early July (Detroit Edison 1976e). In 1977, larvae were collected in Trenton Channel (42°12'30", 83°08'30") from late May to late June (Nester and Hatcher, pers. comm. 1979).

Stony Island (42°07'30", 83°08'00"). White bass spawn about 1/4 mi off the northeast tip of Stony Island in water 4-8 ft deep (Organ et al. 1978).

Livingstone Channel (42°08'00", 83°07'30"). Spawning occurs in a small area with rock substrate at 42°06'10", 83°07'55", between Elba Island and the channel (Organ et al. 1978). In 1977, white bass larvae were collected in the Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") channels from late May to late June; peak abundance occurred in mid-June (Nester and Hatcher, pers. comm. 1979).

Sugar Island (42°05'30", 83°08'40"). Since the 1950s, white bass have spawned along the northern shore of the island in less than about 6 ft of water (Organ et al. 1978).

ROCK BASS

Hickory (Meso) Island (42°05'30", 83°09'00"). Rock bass spawn in the area (42°05'25", 83°09'40") west of the islands in 2-3 ft of water among aquatic vegetation (Organ et al. 1978).

Elba Bay (42°06'00", 83°09'00"). Ripe adults have been collected in the bay in late June. During the 1970s, spawning occurred in about 5 ft of water over a silt bottom in areas with little current (Thomas, pers. comm. 1979).

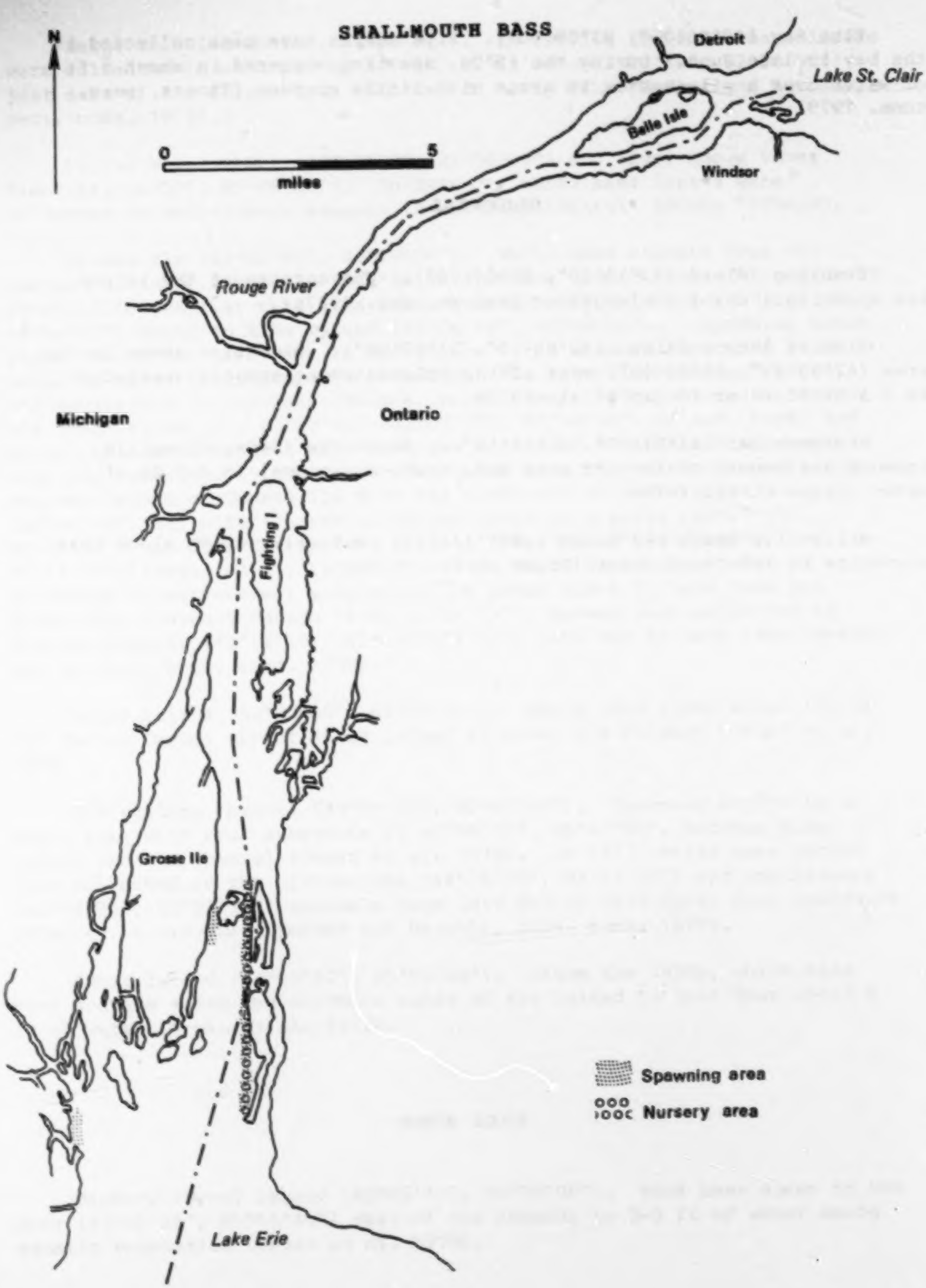
BLUEGILL

Fighting Island (42°13'00", 83°07'00"). The marshes of the island are spawning areas for bluegills (Environ. Can. 1977a).

Hickory (Meso) Island (42°05'30", 83°09'00"). Bluegills spawn in the area (42°05'25", 83°09'40") west of the islands among aquatic vegetation in 2-3 ft of water (Organ et al. 1978).

Sturgeon Bar (42°04'05", 83°11'15"). Since the 1940s, bluegills spawned just south of the bar over mud, sand, and gravel in 1-3 ft of water (Organ et al. 1978).

Milleville Beach (42°02'45", 83°11'15"). Bluegills spawn along this shoreline in 1-3 ft of water (Organ et al. 1978).



SMALLMOUTH BASS

N
0
5
miles
Detroit
Lake St. Clair
Belle Isle
Windsor
Rouge River
Michigan
Ontario
Fighting I.
Grosse Ile
Lake Erie
Spawning area
Nursery area

Historically, smallmouth bass were believed to spawn at the mouth of the river, where there was clear, rapidly moving water (Gunckel 1892).

Livingstone Channel (42°08'00", 83°07'30"). The channel is a major spawning ground; spawning has been observed here since the 1930s. Males have been observed guarding nests in mid-May along dikes on both sides of the channel, throughout the 2-mi length of the channel. Spawning occurs over limestone rock about 1 ft in diam., in 3 ft of water at temperatures of about 55°F. Adults tend to remain in the area after spawning. This area is also a nursery ground (Thomas, pers. comm. 1979).

Grosse Ile (42°08'00", 83°09'00"). Since the 1950s, smallmouth bass have spawned between Grosse Ile and Stony Island (42°07'30", 83°08'00") over rock and gravel (Organ et al. 1978).

Sturgeon Bar (42°04'05", 83°11'15"). Since the 1940s, smallmouth bass have spawned between the bar and the adjacent shoreline in 1-2 ft of water over sand and gravel (Organ et al. 1978).

LARGEMOUTH BASS

Historically, largemouth bass appeared in the river in late May to early June and spawned in August. Spawning occurred in 2-3 ft of water, on gravel banks or in pools or eddies (Jordan 1877).

Crystal Bay (42°07'00", 83°07'15"). Since the 1950s, largemouth bass have spawned at the head of the bay in 2-4 ft of water, on mud, among aquatic vegetation (Organ et al. 1978).

BASS spp.

Fighting Island (42°13'00", 83°07'00"). The marshes of the island provide spawning habitat for black bass (Environ. Can. 1977a).

WHITE CRAPPIE

Elba Island (42°06'10", 83°08'50"). Ripe adults have been collected after April 1 in Smith's Cut (42°06'30", 83°08'10"), north of the island, over a silt bottom in areas with little current. Spawning takes place at a depth of 4-5 ft at a water temperature of less than 40°F. This water is slightly turbid and has little vegetation. Fish are present in the spawning area for about 1 week. White crappies have spawned in this area for about 20 years (Thomas, pers. comm. 1979).

CRAPPIE spp.

Sturgeon Bar (42°04'05", 83°11'15"). Since the 1940s, crappies have spawned just south of the bar over mud, sand, and gravel in 1-3 ft of water during late April and May (Organ et al. 1978).

Milleville Beach (42°02'45", 83°11'15"). Spawning occurs in this area in 1-3 ft of water (Organ et al. 1978).

CENTRARCHID spp.

Belle Isle (42°20'30", 82°58'30"). In 1977, centrarchid larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island from late May to late July (Nester and Hatcher, pers. comm. 1979).

Trenton Channel (42°12'30", 83°08'30"). In 1977, a few larvae were found in early June and late July (Nester and Hatcher, pers. comm. 1979).

Livingstone Channel (42°08'00", 83°07'30"). In 1977, a few larvae were found in late June to late July (Nester and Hatcher, pers. comm. 1979).

Amherstburg Channel (42°08'00", 83°07'10"). One larva was collected in mid-May (Nester and Hatcher, pers. comm. 1979).

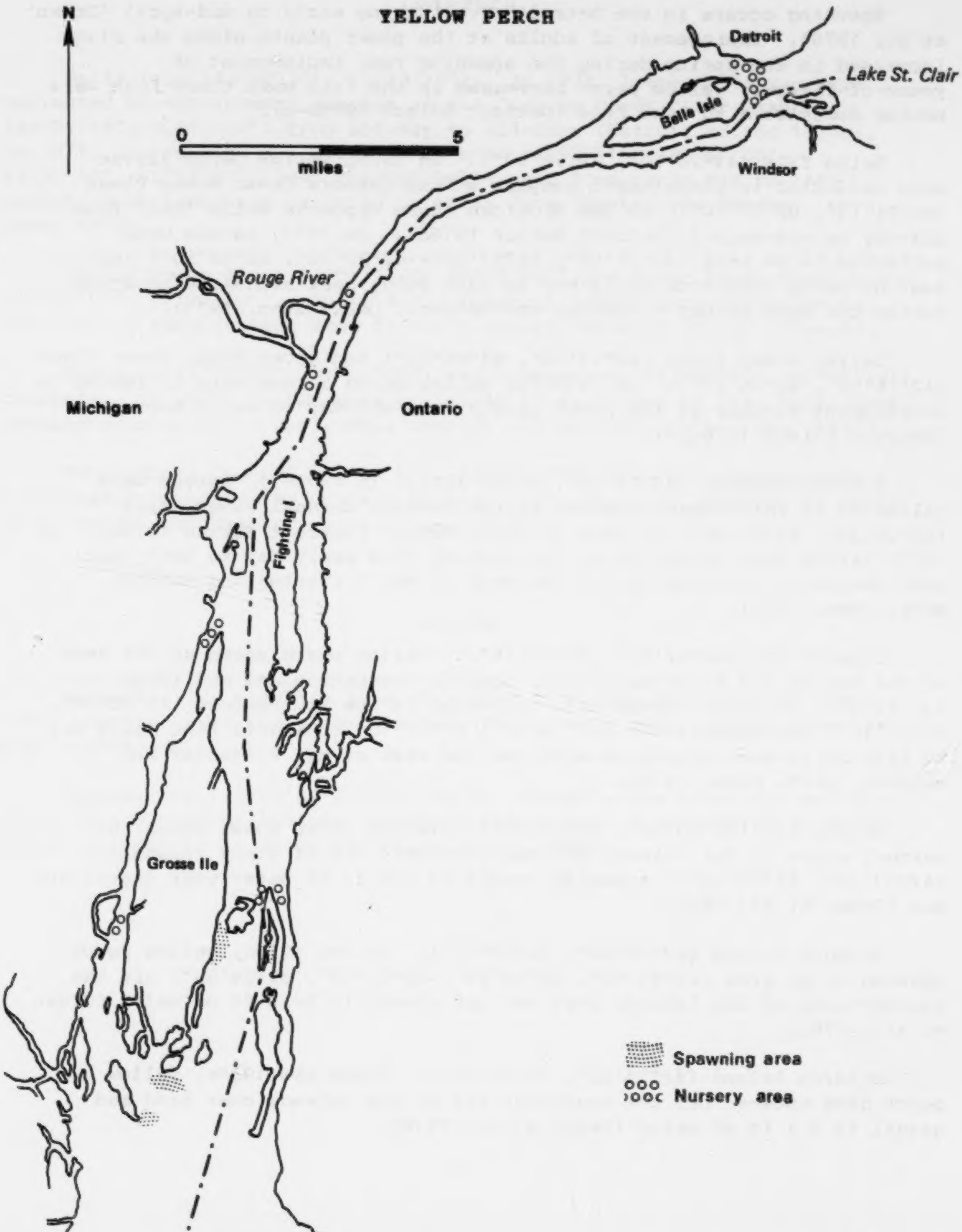
JOHNNY DARTER

Belle Isle (42°20'30", 82°58'30"). In 1977, a few larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island from late May to late June (Nester and Hatcher, pers. comm. 1979).

Trenton Channel (42°12'30", 83°08'30"). In 1977, a few larvae were collected in June (Nester and Hatcher, pers. comm. 1979).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. In 1977, a few larvae were collected in June (Nester and Hatcher, pers. comm. 1979).

YELLOW PERCH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miles
Detroit
Lake St. Clair
Belle Isle
Windsor
Rouge River
Michigan
Ontario
Fighting I
Grosse Ile
Lake Erie
Spawning area
Nursery area

Spawning occurs in the Detroit River during early to mid-April (Organ et al. 1978). Impingement of adults at the power plants along the river increased in the spring during the spawning run; impingement of young-of-the-year yellow perch increased in the fall when these fish were moving downstream to Lake Erie (Detroit Edison 1976b-e).

Belle Isle (42°20'30", 82°58'30"). In 1975, yellow perch larvae were collected in entrainment samples at the Connors Creek Power Plant (42°21'15", 82°57'30"), on the Michigan shore opposite Belle Isle, from mid-May to mid-August (Detroit Edison 1976b). In 1977, larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of Belle Isle from early May to late July; peak abundance occurred during the week of May 9 (Nester and Hatcher, pers. comm. 1979).

Delray Power Plant (42°17'30", 83°06'00") and River Rouge Power Plant (42°16'30", 83°06'30"). In 1974-75, yellow perch larvae were collected in entrainment samples at the power plants from mid-May to early August (Detroit Edison 1976c,d).

Trenton Channel (42°12'30", 83°08'30"). In 1974-75, larvae were collected in entrainment samples at the Trenton Channel Power Plant (42°07'20", 83°11'00") in June to early August (Detroit Edison 1976e). In 1977, larvae were collected in the channel from early May to late June; peak abundance occurred during the week of May 9 (Nester and Hatcher, pers. comm. 1979).

Crystal Bay (42°07'00", 83°07'15"). Yellow perch spawn at the head of the bay in 2-4 ft of water over aquatic vegetation and mud (Organ et al. 1978). In 1977, larvae were collected in the Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") channels from early May to late July; peak abundance occurred the week of May 9 (Nester and Hatcher, pers. comm. 1979).

Grosse Ile (42°08'00", 83°09'00"). Yellow perch spawn along the eastern shore of the island, off the southwest tip of Stony Island (42°07'30", 83°08'00"); spawning occurs in 2-6 ft of water over gravel and mud (Organ et al. 1978).

Hickory Island (42°05'20", 83°09'15"). In the 1970s, yellow perch spawned in an area (42°05'00", 83°09'45"--42°05'05", 83°08'50") off the southern tip of the island, over mud and gravel in 3-14 ft of water (Organ et al. 1978).

Celeron Island (42°04'45", 83°10'30"). Since the 1950s, yellow perch have spawned off the southeast tip of the island, over sand and gravel in 2-3 ft of water (Organ et al. 1978).

LOGPERCH

Belle Isle (42°20'30", 82°58'30"). In 1975, logperch larvae were collected in entrainment samples at the Conners Creek Power Plant (42°21'15", 82°57'30") from mid-May to mid-June (Detroit Edison 1976b). In 1977, larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of Belle Isle from early May to late August; peak abundance occurred in early June (Nester and Hatcher, pers. comm. 1979).

Delray Power Plant (42°17'30", 83°06'00") and River Rouge Power Plant (42°16'30", 83°06'30"). In 1974-75, logperch larvae were collected in entrainment samples from June to early August (Detroit Edison 1976c,d).

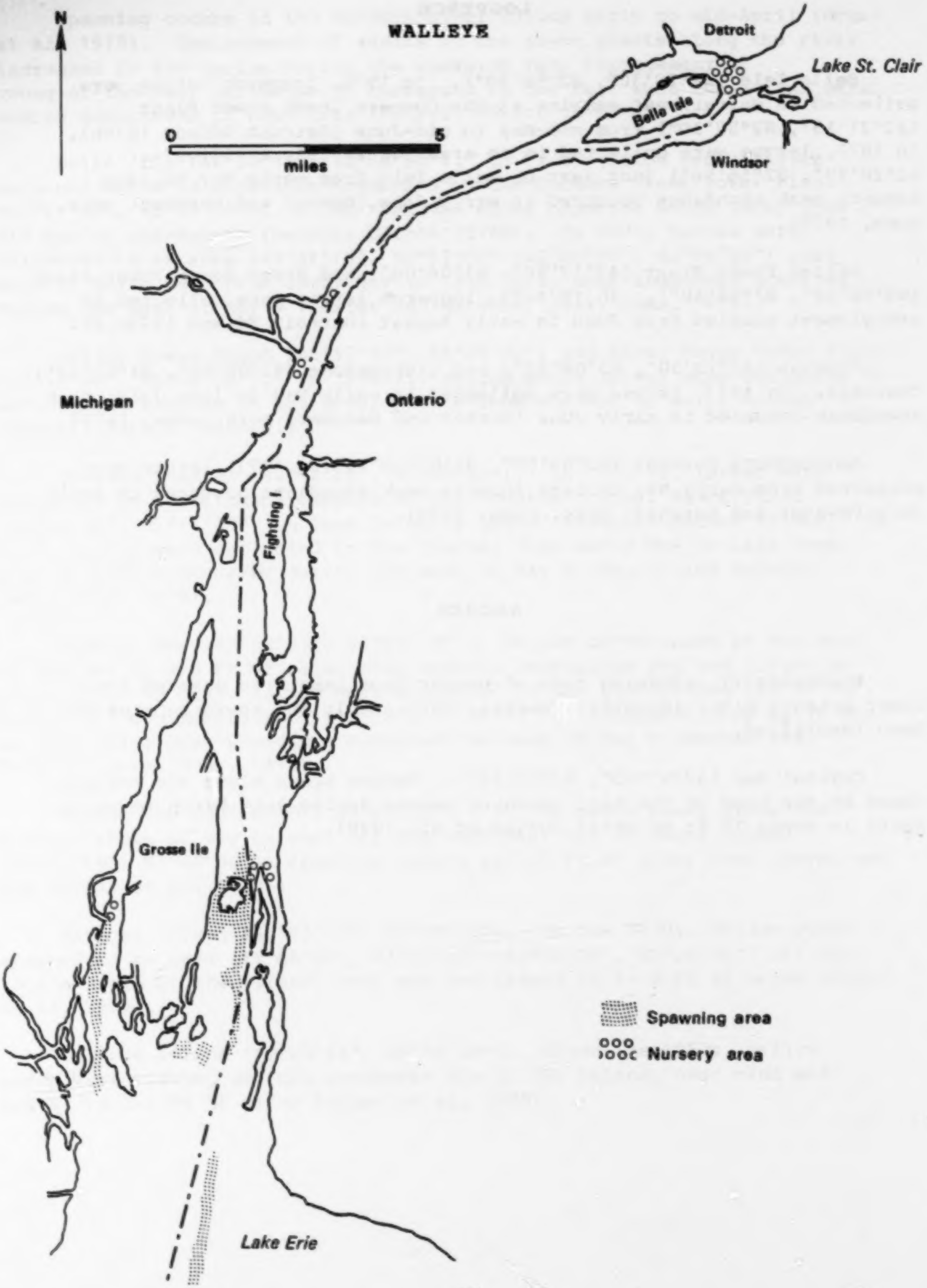
Trenton (42°12'30", 83°08'30") and Livingstone (42°08'00", 83°07'30") Channels. In 1977, larvae were collected in early May to late July; peak abundance occurred in early June (Nester and Hatcher, pers. comm. 1979).

Amherstburg Channel (42°08'00", 83°07'10"). In 1977, larvae were collected from early May to late August; peak abundance occurred in early July (Nester and Hatcher, pers. comm. 1979).

SAUGER

Historically, spawning runs of sauger from Lake Erie entered the lower Detroit River annually (Gunckel 1897). Only one spawning area has been identified.

Crystal Bay (42°07'00", 83°07'15"). Sauger spawn along the western shore at the head of the bay; spawning occurs during late March to early April in about 13 ft of water (Organ et al. 1978).


N
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miles
Detroit
Lake St. Clair
Belle Isle
Windsor
Michigan
Ontario
Fighting I
Grosse Ile
Lake Erie
Spawning area
Nursery area

Spawning runs occurred in the river, presumably from Lake Erie; these declined in the mid-1800s (Schneider and Leach 1979). For several years after 1880, hatchery personnel collected eggs from ripe walleyes captured at Bois Blanc Island (42°05'40", 83°07'15"); but spawning runs to the shores near Detroit were small (Goode 1884, as cited in Regier et al. 1969; Regier et al. 1969).

Historically, walleyes or "pickerel" were believed to spawn annually at the mouth of the river (Gunckel 1892). Pollution and sedimentation have reduced spawning in the river (Busch et al. 1975), but spawning still occurs in some areas (described below) during March to May (Organ et al. 1978), and walleye larvae have been collected in many locations in the river.

The Detroit River is part of a complex migration route, in which one or several populations of walleyes move between the St. Clair-Detroit River system and the western basin of Lake Erie (Applegate and Van Meter 1970; Environ. Can. 1977a; FWS 1979d; Regier et al. 1969; Schneider and Leach 1977). Extensive post-spawning migrations occur from the Maumee Bay area (41°43'00", 83°25'00") into the Detroit River and Lake St. Clair (Van Vooren 1976a).

Belle Isle (42°20'30", 82°58'30"). In 1975, walleye larvae were collected in entrainment samples at the Conners Creek Power Plant (42°21'15", 82°57'30"), on the Michigan shore opposite Belle Isle, in April and May (Detroit Edison 1976b). In 1977, a few larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of Belle Isle in early May (Nester and Hatcher, pers. comm. 1979).

Delray Power Plant (42°17'30", 83°06'00") and River Rouge Power Plant (42°16'30", 83°06'30"). In 1975, walleye larvae were identified in entrainment samples at the Delray plant from late March to mid-June and at the River Rouge plant from mid-February to mid-June (Detroit Edison 1976c,d). [Authors' note: We believe it is unlikely that walleye larvae were present in the river before early April.]

Stony Island (42°07'30", 83°08'00"). During the 1970s, walleyes spawned over mud and vegetation around the island and in an area (42°08'10", 83°07'35") about 1/4 mi NE of the island (Organ et al. 1978).

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. Walleyes spawn over gravel and mud along the western edge of the Livingstone Channel from 42°06'50", 83°07'45" south to 42°05'15", 83°07'55" and in a small area between Powder House Island (42°06'30", 83°08'10") and the channel in 8-14 ft of water (Organ et al. 1978). In 1977, a few larvae were collected in the channel in early May and mid-July and in the Amherstburg Channel in early May (Nester and Hatcher, pers. comm. 1979).

Sugar Island (42°05'30", 83°08'40"). Since the 1950s, walleyes have spawned off the southwest shore of the island over gravel and off the southeast shore over unknown substrate (Organ et al. 1978).

Trenton Channel Power Plant (42°07'20", 83°11'00"). During the 1970s, walleyes spawned from the plant south to Celeron Island (42°04'45", 83°10'30"). Since the 1950s, spawning has occurred over gravel alongshore adjacent to the plant and the Monsanto Company plant (42°07'00, 83°11'00") (Organ et al. 1978). In 1975, walleye larvae were identified in entrainment samples at the power plant from late March to late May (Detroit Edison 1976e).

Detroit River mouth (42°02'40", 83°10'15"). During the 1970s, walleyes spawned in an area (42°03'20", 83°08'10"--42°00'50", 83°08'30"), along the western edge of the Downbound Shipping Channel over gravel and mud (Organ et al. 1978).

FRESHWATER DRUM

Belle Isle (42°20'30", 82°58'30"). In 1977, a few larvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island in June and July (Nester and Hatcher, pers. comm. 1979).

River Rouge Power Plant (42°16'30", 83°06'30"). In 1975, larvae were collected in entrainment samples in late May (Detroit Edison 1976d).

Stony Island (42°07'30", 83°08'00"). During the 1970s, freshwater drum spawned in an area (42°07'05", 83°07'45"--42°08'30", 83°07'35") immediately west of the shipping channel, off the east shore of the island (Organ et al. 1978).

Trenton Channel Power Plant (42°07'20", 83°11'00"). During the 1970s, spawning occurred from the plant south to Celeron Island (42°04'45", 83°10'30") (Organ et al. 1978).

Livingstone Channel (42°08'00", 83°07'30"). Since the 1950s, spawning has occurred in an area (42°06'50", 83°07'45"--42°05'15", 83°07'55") along the western edge of Livingstone Channel over mud and gravel, in 4-8 ft of water (Organ et al. 1978).

Amherstburg Channel (42°08'00", 83°07'10"). In 1977, a few larvae were collected in late May (Nester and Hatcher, pers. comm. 1979).

Detroit River mouth (42°02'40", 83°08'50"). During the 1970s, spawning occurred in an area (42°03'20", 83°08'10"--42°00'55", 83°08'30"), along the western edge of the Downbound Shipping Channel, over mud and gravel (Organ et al. 1978).

FOURHORN SCULPIN

In 1977, a few postlarvae were collected from April-June in the river; spawning probably occurred as far upstream as Lake Huron (Nester and Hatcher, pers. comm. 1979).

Belle Isle (42°20'30", 82°58'30"). A few postlarvae were collected in an area (42°21'15", 82°57'00"--42°20'30", 82°56'50") just east of the island from mid-April to mid-May.

Trenton Channel (42°12'30", 83°08'30"). A few postlarvae were collected from early May to early June.

Livingstone (42°08'00", 83°07'30") and Amherstburg (42°08'00", 83°07'10") Channels. A few postlarvae were collected in early May.

50272-101

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			6.
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15. Supplementary Notes

This document is one of a set of fourteen volumes.

16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.

The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.

The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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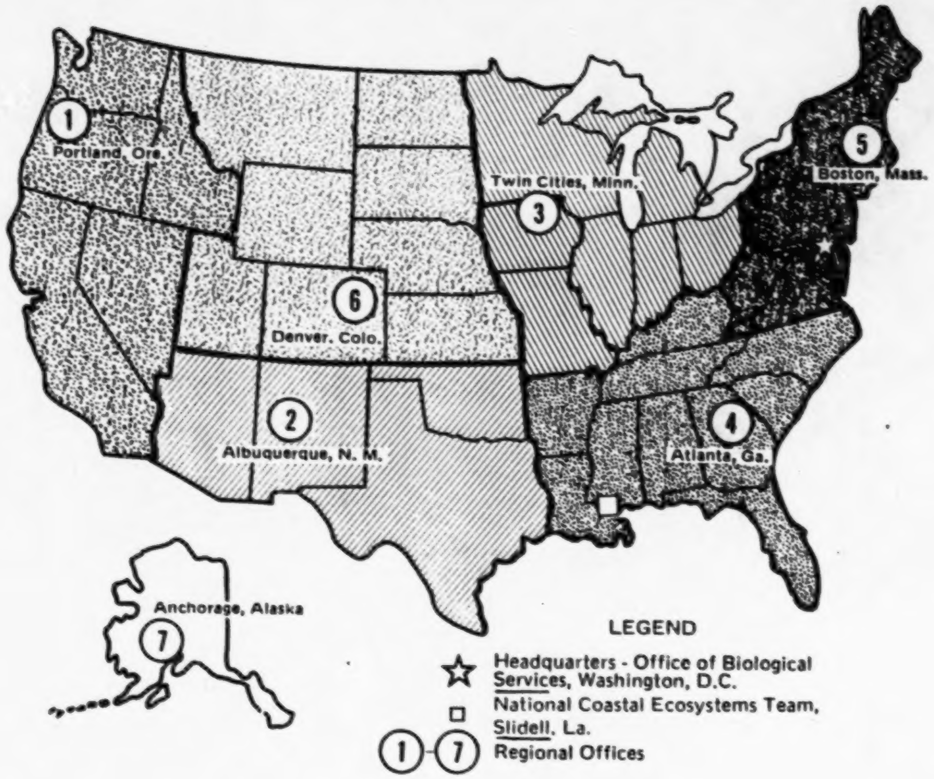
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SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume IX-Lake Erie

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Navigation Season Extension Program**

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME IX
Lake Erie

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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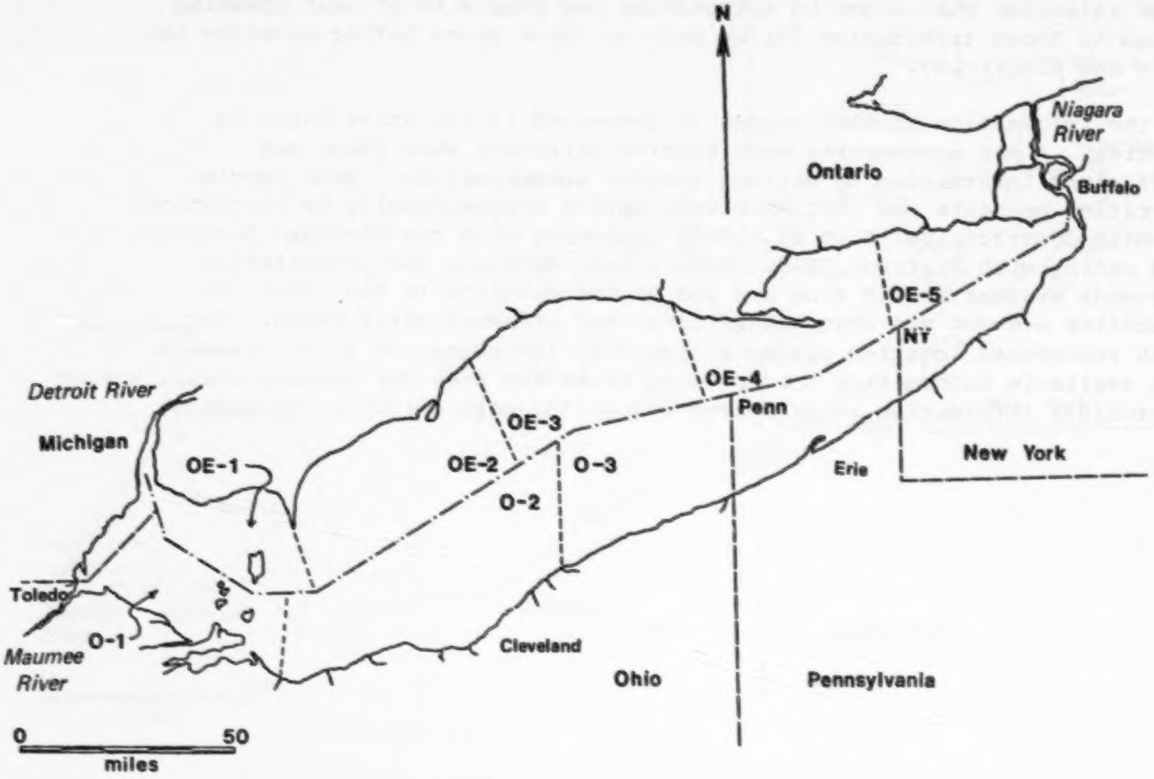
INTRODUCTION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Ontario
Niagara River
Buffalo
OE-5
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OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
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O-2
New York
Erie
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
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50
miles

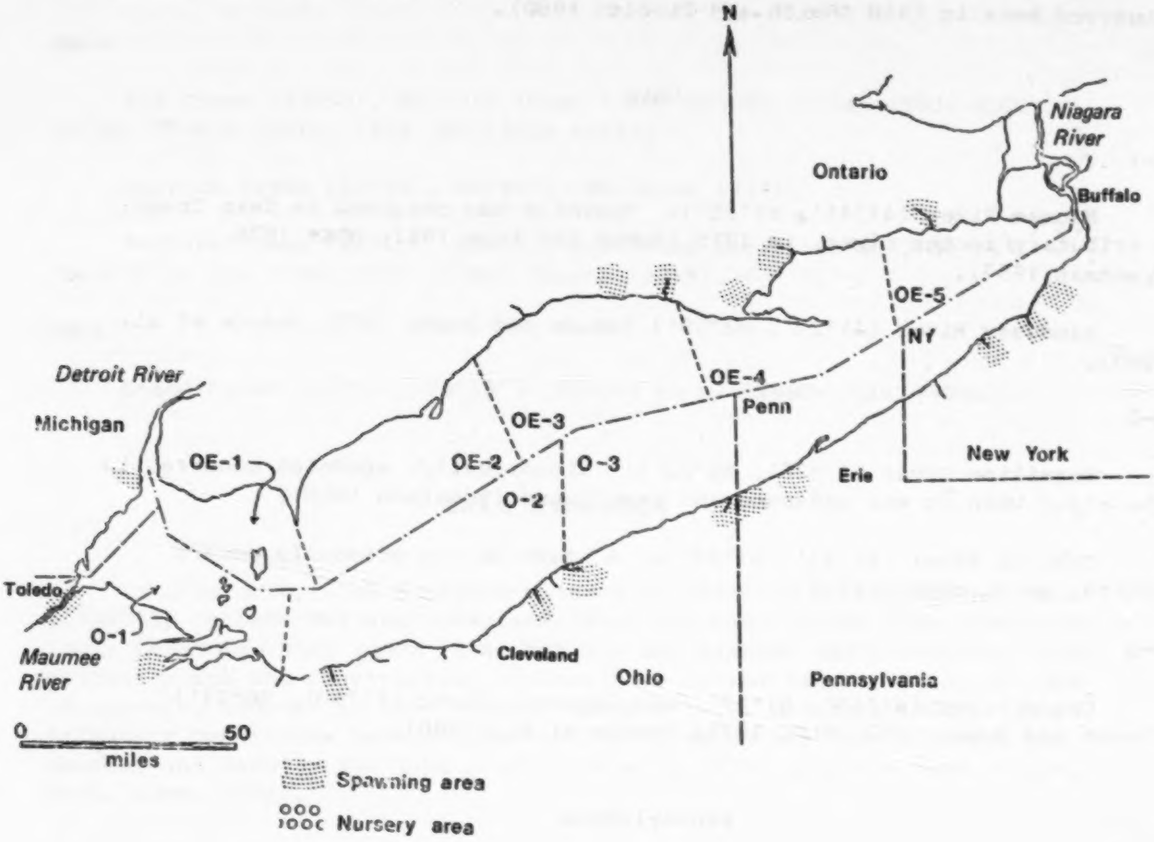
More than 100 species of fish have been recorded as residents in Lake Erie (Baker, pers. comm. 1979; Dymond 1922; Kenyon, pers. comm. 1979; Emery 1976; Muth, pers. comm. 1979; MWRC 1975; Shepherd, pers. comm. 1979; Van Meter and Trautman 1970). This volume describes the reproductive habitat used by the 91 species for which information was available. Eighty-one species treated in this volume were native to the lake. Most of these 81 native species spawned (or spawn) in tributaries or in shallow, protected waters of the lake. Only the emerald shiner utilizes the deep offshore waters, along with the nearshore waters, for spawning.

The ten exotic species treated in this volume were introduced by man or immigrated to the lake during the period of record, from populations established elsewhere in the Great Lakes drainage. Four of these are salmonids which spawn in tributaries; the other six exotic species spawn in tributaries and also in protected nearshore waters in some areas.

Information on nursery areas used by the 91 species treated in this volume is fragmentary, but as would be expected, it suggests that tributaries and nearshore waters are important as nursery areas, at least for the earliest life stages. Dispersal from spawning areas is rapid for some species which have small, pelagic larvae, whereas the juveniles of some salmonids that spawn in tributaries may remain in or near spawning areas in those tributaries for as many as three years before entering the lake and dispersing.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Each species narrative presents the available information systematically by statistical fishing district (Smith et al. 1961) beginning with the Michigan district and ending with district OE-5. Within each district the presentation proceeds systematically from one end of the district to the other, by shoreline segment and adjacent littoral and offshore water areas. For each referenced location within a district, the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

SEA LAMPREY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O-3
New York
Erie
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

The first recorded capture of the sea lamprey in Lake Erie occurred in 1921 (Dymond 1922), 92 years after the completion of the first Welland Canal connecting Lake Erie with Lake Ontario. It is likely that the construction of the second Welland Canal in 1914-1932 further facilitated the movement of sea lampreys from Lake Ontario to Lake Erie (Morman et al. 1980). The first recorded spawning run in a Lake Erie tributary occurred in the Huron River (Michigan) in May 1932 (Creaser 1932b). The population in Lake Erie is small because only a few tributaries have suitable spawning habitat (Applegate and Moffett 1955; Beeton 1966, 1969; Dees 1980; Hartman 1972; Pearce et al. 1980; Smith 1971); ammocoetes have been found in only 14 streams (Pearce et al. 1980). The tributaries listed below are classified as spawning streams based on the presence of ammocoetes, spawning adults, or both.

Michigan

Huron River (42°02', 83°12') (Creaser 1932b). A run was last observed here in 1938 (Smith and Tibbles 1980).

Ohio

O-1

Maumee River (41°41', 83°28'). Spawning was observed in Swan Creek, a tributary to the river, in 1935 (Hubbs and Pope 1937; ODNR 1976; Trautman 1957).

Sandusky River (41°27', 82°59') (Braem and Rugen 1977; Pearce et al. 1980).

O-2

Vermilion River (41°26', 82°22'). Historically, spawning occurred in the river when it was undammed and unpolluted (Trautman 1950).

Chagrin River (41°41', 81°26'). A spawning run presently occurs (White, pers. comm. 1979).

O-3

Grand River (41°46', 81°17') and Conneaut River (41°58', 80°33') (Braem and Rugen 1977; GLFC 1975; Pearce et al. 1980).

Pennsylvania

Raccoon Creek (41°59', 80°29') and Crooked Creek (42°00', 80°26') (Braem and Rugen 1977; GLFC 1975; Pearce et al. 1980).

Walnut Creek (42°04', 80°14') (Kenyon, pers. comm. 1979).

New York

Canadaway Creek (42°28', 79°22'), Cattaraugus Creek (42°34', 79°08'), and Delaware Creek (42°38', 79°04') (Pearce et al. 1980).

Ontario

Most Ontario tributaries to Lake Erie do not have suitable spawning habitat for sea lampreys (Hogg 1955).

OE-3

Catfish Creek (42°39', 81°01') and Big Otter Creek (42°37', 80°48') (Pearce et al. 1980; SLCC 1979a).

OE-4

Big Creek (42°36', 80°27') (Hogg 1955; Pearce et al. 1980; SLCC 1979a; Thomas 1961b, 1962; Whillans 1977).

Dedrick Creek (42°36', 80°27') (Whillans 1977).

Potters Creek (42°43', 80°19') and Young Creek (42°45', 80°15') (Pearce et al. 1980; SLCC 1979a; Thomas 1961b).

OE-5

Grand River (42°51', 79°35') (Pearce et al. 1980; SLCC 1979a).

LAKE STURGEON

In Lake Erie, lake sturgeon entered tributaries in the spring, primarily in late May and June, and later returned to the lake (Bean 1902, 1903; Langlois 1954; Moore 1894; Rathbun and Wakeham 1897; Trautman 1977). Siltation and the construction of dams have denied lake sturgeon the use of spawning habitat in most rivers (Hartman 1972; Langlois 1954). After tributary conditions became unfavorable, spawning may have occurred on beaches and bars in the lake proper (Greeley 1929; Langlois 1954; White, pers. comm. 1979).

Michigan

Detroit River (42°03', 83°08'). Hennepin's writings of his travels in 1675 reported that lake sturgeon migrated to the banks of the lake near the mouth of the Detroit River to spawn (MSBFC 1893). Spawning was observed near the river mouth (Harkness and Dymond 1961; Langlois 1954).

Huron River (42°02', 83°12'). Historically, a spawning run entered the river (Langlois 1954).

Stony Point (41°56', 83°16'). During the 1890s-1900s lake sturgeon spawned in an area (41°55', 83°16') 1/2 mi S of Stony Point over clay bottom in about 18 ft of water (Organ et al. 1978).

Ohio

O-1

Maumee River (41°41', 83°28'). Prior to 1900, large spawning runs occurred in the Maumee River upstream to the rapids at Perrysburg and to Waterville; these runs were eliminated by 1885 (Kirsch 1895; Langlois 1954; Smith and Snell 1891; Trautman, pers. comm 1979). Spawning declined in Maumee Bay (41°43', 83°25') because adults could not reach the spawning grounds (Pinsak and Meyer 1976).

Portage River (41°31', 82°56'). Historically, a spawning run entered the river (Langlois 1954, 1965).

Sandusky River (41°27', 82°59'). The lowland swamp forests and flooded prairies were once favorable spawning sites (Trautman 1975). During the mid-1800s, lake sturgeon weighing from 70-100 lbs were commonly observed migrating up the river in the spring (Keeler 1904). Spawning runs declined when mill dams built in the 1800s and the Ballville Dam built in the early 1900s blocked the passage to spawning grounds (Hartley and Herdendorf 1975).

O-2

Cuyahoga River (41°30', 81°43'). The river supported a spawning run until approximately 1850, when pollution destroyed the spawning grounds in the lower reaches of the river (Kirtland 1850, as cited in Trautman 1957; USDI 1967; White, pers. comm. 1979).

O-3

Conneaut (41°58', 80°33'). Spawning occurred on rocky bottom along shore, where lake sturgeon were very abundant in June and July (Smith and Snell 1891).

Pennsylvania

Walnut Creek (42°04', 80°14'). During the 1950s ripe fish were caught just east of the creek; it is not known where these fish spawned (Larsen, pers. comm. 1979).

New York

Dunkirk (42°29', 79°20'). Historically, spawning occurred here (Harkness and Dymond 1961).

Silver Creek (42°33', 79°10'). Lake sturgeon probably spawned at the mouth of the creek (Smith and Snell 1891).

Buffalo (42°55', 78°53'). Lake sturgeon spawned on bars near Buffalo Harbor (42°52', 78°53') until these were removed by dredging (Greeley 1929; Harkness and Dymond 1961). The most important fishery was carried out during the spawning season along the Erie County shore between Buffalo and Irving (42°34', 79°07'); the heaviest run occurred from mid- or late May to early June (Moore 1894, Smith and Snell 1891). Spawning probably occurred along this entire shoreline (Rathbun and Wakeham 1897).

Ontario

OE-1

Pelee Island (41°47', 82°40'). Many lake sturgeon were caught around the island in early May and June, and spawning was believed to occur here (Rathbun and Wakeham 1897).

Point Pelee (41°55', 82°30'). Historically, spawning was observed over hard clay, gravel or shale, and boulders near the point (Langlois 1954; Rathbun and Wakeham 1897). In 1952, spawning was reported on shoals at the point in June, but this report was not confirmed (Langlois 1954).

OE-2

Rondeau Harbour (42°15', 81°53'). In about 1890, the bays here were considered to be spawning areas (Kerr and Kerr 1860-1898).

OE-4

Clear Creek (42°34', 80°35'). In 1891, a good run entered the creek in May and June (Kerr and Kerr 1860-1898).

Long Point Bay (42°40', 80°10'). Inner Bay (42°37', 80°22') was an important spawning area, especially in Sturgeon (42°36', 80°23') Little Rice (42°35', 80°21') and at Turkey Point (42°39', 80°21') bays, but these areas have not been used since at least the 1920s (Kerr and Kerr 1860-1898; Whillans 1977, 1979a). Sturgeon spawned on the lakeward side of the tip of Long Point (42°33', 80°05'); ripe fish were taken and spawning was observed there as recently as the early 1960s (Whillans, pers. comm. 1979).

SPOTTED GAR

Ohio

Spotted gars spawned in the marshy areas along the Ohio shore until 1930, when most of the marshes were destroyed (Trautman, pers. comm. 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). A resident population of spotted gars spawns over vegetation in the lagoon area of Presque Isle Bay. Spawning was observed during mid- to late May (Kenyon, pers. comm. 1979).

LONGNOSE GAR

The longnose gar spawns in shallow water during May and June (Fish 1932; Langlois 1954).

Michigan

Monroe (41°55', 83°24'). Adults move into the discharge canal of the Monroe Power Plant (41°53', 83°21') during the spawning season; larvae were also collected in the canal (Cole 1976).

Long Point (possibly Woodtick Peninsula, 41°44', 83°25'). In 1948, young-of-the-year (YOY) were collected along the Michigan shore at Long Point in mid-July (Langlois 1954).

Ohio

During the 1800s, large schools of longnose gars entered rivers in Ohio during April to spawn (McCormick 1892; White, pers. comm. 1979).

O-1

Maumee River (41°41', 83°28'). Spawning runs of longnose gars enter the Maumee River (Trautman, pers. comm. 1979).

South Bass Island (41°39', 82°50'). Spawning occurs in shallow, vegetated areas between South Bass Island and Starve Island (41°38', 82°49') and also in Squaw Harbor (41°39', 82°49') and Terwilliger Pond (41°39', 82°50') during mid-May to mid-June (Langlois 1954; Trautman, pers. comm. 1979). Substrate varies from mud to rocky shoreline. Water temperature ranges from 66-70°F; most spawning activity occurs at 66°F (Langlois 1954). The beds of vegetation between South Bass and Starve Islands and in Squaw Harbor are also nursery areas. Fry were observed lying on the tops of leaves among dense beds of aquatic vegetation (Trautman, pers. comm. 1979). Young-of-the-year were also observed in association with schools of young smallmouth bass in Fishery Bay (41°39', 82°49') (Langlois 1954).

Sandusky Bay (41°29', 82°46'). In 1953, spawning was observed in Winous Point Marsh (41°28', 82°59') at the head of Sandusky Bay during May (Langlois 1954). Some spawning occurs in the bay (FWS 1979d).

O-2

Chagrin Harbor (41°41', 81°26'). In 1972-74, YOY were collected in the lower Chagrin River and adjacent shoreline areas (White et al. 1975); larvae were also collected in Chagrin Harbor (White, pers. comm. 1979).

O-3

Ashtabula (41°55', 80°47') and Conneaut (41°58', 80°33'). Larvae were collected in the harbors here (White, pers. comm. 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). A resident population of longnose gars spawns in the shallow lagoon areas over vegetation (Kenyon, pers. comm. 1979; Larsen 1952); spawning usually occurs from late May to mid-June (Larsen 1952). Young-of-the-year were collected in vegetated backwater areas during August (Kenyon, pers. comm. 1979).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Longnose gars are believed to spawn in this area in mid-April (Reid 1978). Fishermen see them in the spring in many shallow areas of Inner Bay (42°37', 80°22'), including Sturgeon Bay (42°36', 80°23'), Coletta Bay (42°35', 80°26'), marshes at the mouth of Big Creek (42°36', 80°27'), and Turkey Point (42°39', 80°21'), (Whillans, pers. comm. 1979); YOY are found during July and August in these same marsh areas (Hamley and MacLean 1979; Reid 1978; Whillans, pers. comm. 1979). Reproducing populations are also probably established in the larger lagoons at the tip of Long Point (42°33', 80°05') (Mahon 1979).

BOWFIN

The bowfin spawns in protected bays over vegetated mud bottom (Langlois 1954). Larvae are found in weedy areas nearshore, in harbors, and in rivers (White, pers. comm. 1979).

Michigan

Bolles Harbor (41°51', 83°24'). Since 1921, spawning has occurred in an area (41°51', 83°22') 1-1/2 mi E of Bolles Harbor, along the 6 ft depth contour, over a mud substrate (Organ et al. 1978).

Ohio

O-1

South Bass Island (41°39', 82°50'). In 1953, several males in breeding colors were caught in Fishery Bay (41°39', 82°49') in June (Langlois 1954).

Winous Point Marsh (41°28', 82°59'). A school of young was collected in the marsh (Langlois 1954).

O-2

Old Woman Creek (41°23', 82°31'). The mouth of the creek is excellent spawning habitat (FWS 1979d).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). A resident population spawns in the lagoon area of the bay. Bowfins spawn there at depths of less than 6 ft, among weedy, submergent vegetation; ripe males and gravid females were collected among the vegetation and young-of-the-year (YOY) were collected in the area in September (Kenyon, pers. comm. 1979).

Ontario

OE-2

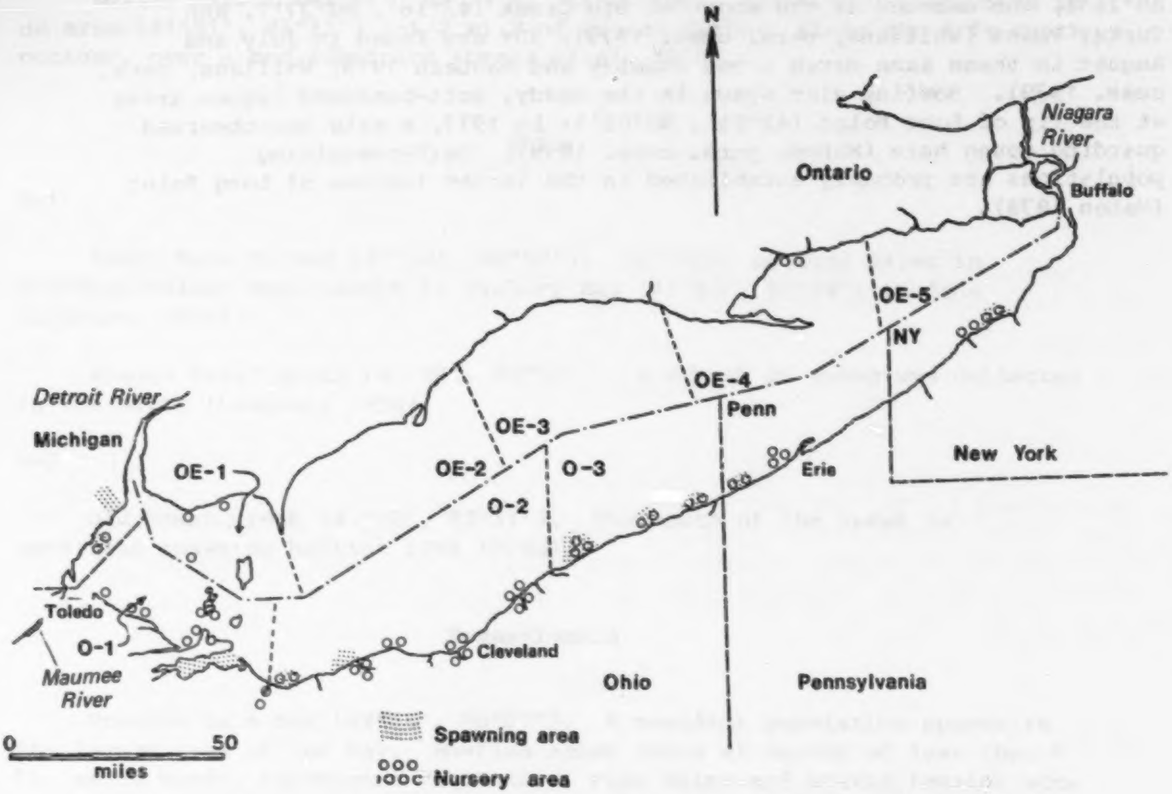
Rondeau Harbour (42°15', 81°53'). Bowfin nests were observed in marshes in the Rondeau Harbour area. Eggs were found adhering to decaying vegetation on the bottom of the nests and to surrounding upright reed stems in water less than 1 ft deep at temperatures of about 77°F (Doan 1938). "The Ponds" along the southeast shore is a major spawning area, where adults were seen guarding nests in June (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). During the late 1880s and mid-1890s, bowfins spawned at Turkey Point (42°39', 80°21') in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898). Bowfins are numerous in the area, although there was a brief decline in the population in the early

1960s (Whillans 1977). They are thought to spawn in early May (Reid 1978), and fishermen see them during the spring in many shallow areas of Inner Bay, including Sturgeon Bay (42°36', 80°23'), Coletta Bay (42°35', 80°26'), the marshes at the mouth of Big Creek (42°36', 80°27'), and Turkey Point (Whillans, pers. comm. 1979); YOY are found in July and August in these same marsh areas (Hamley and MacLean 1979; Whillans, pers. comm. 1979). Bowfins also spawn in the muddy, soft-bottomed lagoon areas at the tip of Long Point (42°33', 80°05'); in 1977, a male was observed guarding young here (Mahon, pers. comm. 1979). Self-sustaining populations are probably established in the larger lagoons of Long Point (Mahon 1979).

ALEWIFE


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
New York
OE-1
OE-2
O-3
Erie
O-2
Toledo
O-1
Cleveland
Maumee River
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

The alewife presumably entered Lake Erie from Lake Ontario via the Welland Canal. Alewives were first observed in Lake Erie in 1931 and became abundant in about 1950 (Miller 1957).

In the central basin, alewives spawn close to shore, primarily in harbor areas (Wolfert, pers. comm. 1979).

The western basin is the major spawning and nursery area in Lake Erie (Doremus 1975). Alewives spawn almost everywhere throughout the basin (Wolfert, pers. comm. 1979). Most of the hatching in the basin occurs during June 15-30 at 72°F (Comm. Fish. Rev. 1961a). Numerous young-of-the-year (YOY) were collected in the basin; they first appeared in mid-July (Baker 1966; Van Vooren and Davies 1974; Van Vooren et al. 1977). The wide size range of YOY collected in the fall indicated an extended spawning season (Parker 1964).

Michigan

Huron River (42°02', 83°12'). Alewives enter the river and run upstream to the Flat Rock Dam to spawn (Janssen, pers. comm. 1979).

Raisin River (41°53', 83°20'). Alewives spawn at the mouth of the Raisin River in 1-3 ft of water and also just off the discharge of the Monroe Power Plant (41°53', 83°21') over mud and aquatic vegetation (Organ et al. 1978). Large catches of YOY during the early 1970s indicate that the area around the mouth of the Raisin River and north to Sterling State Park (41°55', 83°20') is a nursery area (Ball and Scholl 1973; Hair and Scholl 1971; MDNR 1970-1976; Parkhurst 1971; Rudolph and Scholl 1970).

Ohio

Alewives move from deeper water into nearshore shallows or into tributaries to spawn in June and July (Trautman 1957).

O-1

Potters Pond (41°41', 83°18'). In 1962, YOY were fairly abundant in August off Potters Pond (Ayers et al. 1970).

Crane Creek (41°38', 83°12'). Young-of-the-year are fairly abundant off Crane Creek (Gehres and Scholl 1969; Hair and Scholl 1971; USNRC 1973, 1975a).

Locust Point (41°36', 83°05'). Young-of-the-year were very abundant inshore in July and August off the point (Barnes and Reutter 1979; CLEAR 1976; Reutter and Herdendorf 1974, 1977; USNRC 1975b).

Catawba Island (41°35', 82°51'). In 1966, a high concentration of YOY was found in an area (approximately 41°34', 82°53') west of Catawba Island in early August (Baker 1967a).

East Harbor (41°32', 82°47'). In 1966, 1967, and 1969, high densities of YOY were found inside and just outside of East Harbor in late July and early August (Baker 1967a,c; Ball and Scholl 1973; Gehres and Scholl 1969; Rudolph and Scholl 1970).

Middle Sister Island (41°51', 83°00'). In 1966, one of the highest concentrations of YOY was found just south of Middle Sister Island in early August (Baker 1967a).

South Bass Island (41°39', 82°50'). In 1953, YOY were collected around the island in mid-July (Langlois 1954).

Sandusky Bay (41°29', 82°46'). The bay is a minor spawning area (FWS 1979d).

O-2

Huron River (41°24', 82°33'). In 1976, fry were moderately abundant in the lower Huron River (Cleveland Environ. Res. Group, undated).

Erie Nuclear Plant site (41°23', 82°30'). In 1974, spawning in this area began in early May, when the water temperature was below 54°F. Eggs and prolarvae were collected in shallow water less than 10 ft deep in June and July, and it was assumed that spawning occurred near shore. Densities of larvae peaked on July 10. Larvae were common in surface collections in water about 16-33 ft deep, suggesting that they moved away from shore after hatching (Ohio Edison Company 1977).

Beaver Creek (41°26', 82°15'). In 1979, prolarvae and postlarvae were collected to the 36 ft depth contour off the creek; YOY were collected in late August (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). In 1975, alewife larvae were abundant in Lorain Harbor in July (Wapora 1977a); in 1977 they were very scarce in the harbor (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1977-78, 6% of the larvae entrained during the summer at the plant were alewives (Applied Biology 1979c).

Cleveland (41°30', 81°43'). In 1972-74, fry or YOY were abundant in Cleveland Harbor (41°31', 81°42') and in the lower Rocky River (41°30', 81°50') and adjacent shore areas; these may be spawning areas (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, alewife fry or YOY were abundant in the lower river and adjacent shore areas; this may be a spawning area (White et al. 1975).

O-3

Perry Power Plant (41°48', 81°09'). Prolarvae and postlarvae have been found in the vicinity of the plant. Many juveniles about 1-2 in. long were seined along shore in late July and late August (NUS 1975).

Ashtabula (41°55', 80°47') and Conneaut (41°58', 80°33'). Alewives spawn outside the harbor breakwalls on the beach and on gravel bars (White, pers. comm. 1979). Alewives were 7% of the larvae collected in the lake near Ashtabula in the spring (Applied Biology 1979d,e). In 1977, alewife fry were collected in Conneaut Harbor in August (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22'). Adults in spawning condition were found in the lake off the creek in July; larvae were also collected here (GPU Serv. Corp. 1979).

Walnut Creek (42°04', 80°14'). In 1973, YOY less than 0.5 in. long, were collected in an area (42°06', 80°14') off the creek mouth in about 30 ft of water, over a sand bottom in July (Kenyon, pers. comm. 1979).

New York

Van Buren Bay (42°27', 79°25'). No alewive eggs or prolarvae were collected, but postlarvae were more abundant those those of most other species from early June to late August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk (42°29', 79°20'). Prolarvae were found here in June and entrained by the Dunkirk Steam Station (42°30', 79°21') in June and July. Alewife postlarvae were entrained in June to August and were more abundant than those of most other species at that time (Tex. Instrum. 1977d,e).

Eagle Bay (42°32', 79°14'). Alewife eggs were found off Eagle Bay in late May and mid-June (Tex. Instrum. 1977a). Prolarvae were collected from mid-June to mid-July and postlarvae were found from mid-June to August. Young-of-the-year appear in July and are abundant in August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

OE-1

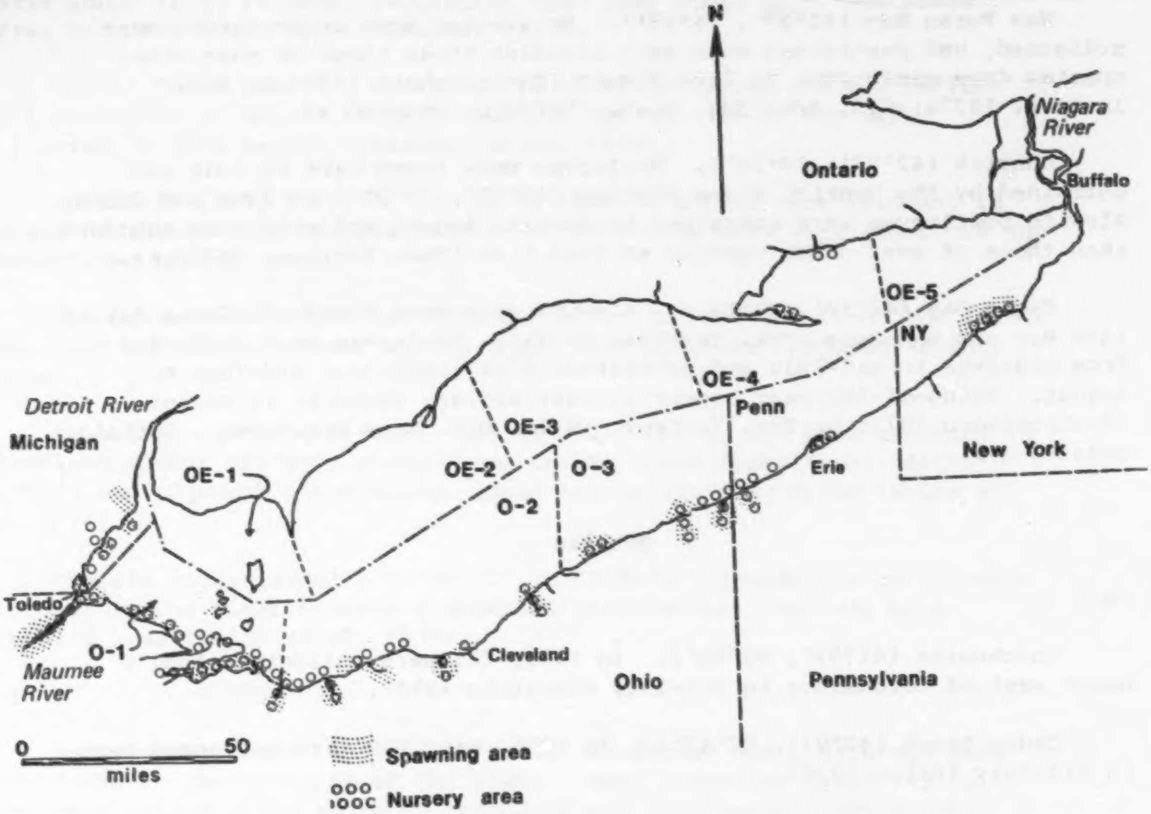
Colchester (41°59', 82°56'). In 1953, YOY were collected along a beach west of Colchester in mid-July (Langlois 1954).

Cedar Beach (42°01', 82°47'). In 1975, many YOY were collected here in mid-July (Paine 1976).

OE-4

Long Point Bay (42°40', 80°10'). In 1974, young-of-the-year (YOY) alewives were entrained at the Nanticoke Generating Station (42°48', 80°03') from June to August (Hamley and MacLean 1979; Teleki 1976). In 1976, YOY also dominated the shore seine catch in the Stelco dock area (42°47', 80°05') from July to September (Chamberlain 1976). Adult alewives are especially abundant in the Nanticoke plume during the spring (Hamley and MacLean 1979).

GIZZARD SHAD


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-1
OE-3
OE-2
O-3
O-2
Erie
New York
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

The gizzard shad may be native to Lake Erie, however the species was first reported in the lake in 1848, 18 years after the first canal connecting the lake with the Ohio River was completed (Miller 1957). Gizzard shad are now common throughout most of the inshore waters of Lake Erie; they are often attracted to warm water outlets (Wolfert, pers. comm. 1979). Gizzard shad spawn in harbors and rivers in the central basin of Lake Erie, mainly near breakwalls and dock pilings over Cladophora beds (White, pers. comm. 1979). The western basin is the major spawning and nursery area for gizzard shad in Lake Erie (Doremus 1975). Spawning occurs almost everywhere throughout the basin, but the more turbid areas centered mainly in Maumee Bay and Sandusky Bay appear to be the primary spawning and nursery areas. Large numbers of adults ascend rivers along the Ohio shoreline to spawn in May to July; peak spawning occurs in mid-June at a minimum water temperature of 67°F (Bodola 1966; CLEAR 1978a,b; Heniken 1977; Wapora 1977c; Wolfert, pers. comm. 1979). In 1960, the major hatching period in the western basin was June 15-30 at a water temperature of 72°F (Comm. Fish Rev. 1961a), but fry were captured as early as late May (Baker 1966b; Manz 1963). Young-of-the-year (YOY) are abundant; they first appear in trawls in late June and early July and peak catches are made in late August (Van Vooren and Davies 1974; Van Vooren et al. 1977).

Michigan

Huron River (42°02', 83°12'). During the 1960s, gizzard shad ran upstream to the dam at Flat Rock to spawn (Janssen, pers. comm. 1979).

Swan Creek (41°58', 83°15')--Point aux Peaux (41°57', 83°15'). Since 1950, gizzard shad have spawned along this shoreline over mud bottom at depths to 16 ft (Organ et al. 1978). Yolk-sac larvae are abundant inshore during early June. Late postlarvae were collected in early July; abundance decreased by mid-July and early August (Detroit Edison 1978).

Raisin River (41°53', 83°20'). The large numbers of larvae and YOY collected here indicate that the area around the mouth of the river is a nursery area; in 1977, they were found in an area (41°54', 83°21') in early June near the mouth of the river (Patterson 1979a). In 1969-76, YOY were abundant from Sterling State Park (41°55', 83°20') south to the river (Gehres and Scholl 1969; Hair and Scholl 1971; MDNR 1970-76; Rudolph and Scholl 1970). Many young were collected in the discharge canal of the Monroe Power Plant (41°53', 83°21') (Parkhurst 1971). The lower end of the canal including its mouth could provide excellent spawning habitat for gizzard shad (Nelson 1975; Nelson and Cole 1975). Occasionally, large numbers of YOY also appear in the intake canal in July (Eisele and Malaric 1977). Since 1950, gizzard shad have spawned at the mouth of the river and along the adjacent shoreline south to the plant discharge canal in 8 ft or less of water (Organ et al. 1978).

Toledo Beach (41°50', 83°24'). In 1977, gizzard shad larvae were found in early to mid-June in an area (41°49', 83°22') about 2-1/4 mi off Toledo Beach (Patterson 1979a).

Woodtick Peninsula (41°44', 83°25'). Since 1950, gizzard shad have spawned over mud bottom in 10 ft of water or less along the northern shore of the peninsula from 41°47' to 41°46' (Organ et al. 1978). In 1974, YOY were found there (MDNR 1970-76). In 1978, gizzard shad were the dominant larvae entrained at the Whiting Power Plant (41°47', 83°27'); peak entrainment of gizzard shad larvae and peak abundance in the bay occurred in June (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). The bay is one of the major areas of concentration in the western basin (Heniken 1977). Gizzard shad migrate upstream through the bay to spawn in tributaries of the Maumee River

(41°41', 83°28') (Trautman and Gartman 1974). Since 1952, spawning occurred in the western part of the bay from 41°42', 83°27' north to Indian Island (41°45', 83°27') (Organ et al. 1978). Spawning also occurred during May 15-August 15 over the sand and gravel channel "side castings" (Pinsak and Meyer 1976). Ripe adults were found in the bay in May (USACE 1976c). The Maumee estuary is a nursery area, and the young remain in the river through the later developmental stages; they tend to concentrate at the surface by the end of May after reaching a length of 0.3-0.4 in. (CLEAR 1977; Reutter, Herdendorf and Sturm 1978a,b; Snyder 1978; Wapora 1977c). Larvae appear to be concentrated in the lower river, mainly at the mouth in late June (Wapora 1977b). In 1975-77, larvae and YOY were very abundant throughout the bay and in the lower Maumee River in May to July (Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Herdendorf et al. 1976; Patterson 1979a). Very large concentrations were present at the mouth of the bay; many larvae were found at Turtle Island (41°45', 83°23') (Herdendorf et al. 1976). In 1977, large concentrations of postlarvae were found at Cedar Point (41°42', 83°20') (Patterson 1979a). Young-of-the-year are reported to overwinter in the bay (FWS 1979d).

Metzger Marsh (41°39', 83°14'). In 1976, high densities of larvae were present in mid- to late June along the shoreline of the marsh, which is used extensively for spawning (Heniken 1977). In 1977, high concentrations of early postlarvae were found in early to mid-June inshore near Ward Canal (41°39', 83°14') (Patterson 1979a).

Crane Creek (41°38', 83°12'). Young-of-the-year were very abundant off Crane Creek in 1971 (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; USNRC 1973, 1975a).

Locust Point (41°36', 83°05'). Eggs and larvae of gizzard shad dominate collections in the Locust Point area, where spawning occurs from early June to early July; abundance was especially high near the intake and discharge of the Davis-Besse Power Station (41°36', 83°04') (CLEAR 1975b, 1976; Heniken 1977; Reutter 1979b,c; Reutter and Herdendorf 1977; USNRC 1973, 1975a,b). Large numbers of YOY are present along shore from mid-June through the summer (Barnes and Reutter 1979; CLEAR 1975a, 1975b, 1976; Reutter and Herdendorf 1977). Extremely high numbers of larvae, 1.1-1.4 in. long and YOY were present at the Davis-Besse Station in mid-June and early July (Reutter and Herdendorf 1974).

Catawba Island (41°35', 82°51'). High densities of YOY were collected in an area (approximately 41°34', 82°53') just west of Catawba Island (Baker 1967a; Ball and Scholl 1973; Hair and Scholl 1971).

East Harbor (41°32', 82°47'). During 1966 to 1973, YOY were found in large concentrations inside and outside the harbor (Baker 1967a; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970).

South Bass Island (41°39', 82°50'). In the early 1950s, spawning gizzard shad were collected in greatest numbers on a bar extending from Oak Point (41°39', 82°49') to Gibraltar Island (41°39', 82°49') in 2-4 ft of water over sand, gravel, and boulders with aquatic vegetation. Spawning occurred from early June to mid-July, and peaked in mid-June (Bodola 1955, 1966).

Sandusky Bay (41°29', 82°46'). Sandusky Bay is one of the major areas of concentration in the western basin (Heniken 1977), and successful spawning occurs in the bay (FWS 1979d). In 1953, large numbers of ripe fish were taken in the western end of the bay in early June (Langlois 1954). Two peaks of adult abundance were observed in the bay; one in April and May, and a second in August. These peaks probably reflect the movement inshore by adults, to spawn in small streams and ditches of the bay, and the subsequent movement back into the bay after spawning is completed (Hartley and Herdendorf 1975). In 1954, spawning was observed in late May along a stony shore at a water temperature of 63°F (Bodola 1966). Sandusky Bay is a nursery area; larvae remain in the Sandusky River (41°27', 82°59') through later development stages (CLEAR 1977). Concentrations of larvae are especially high, often exceeding 1000/m^3, at the river mouth (Heniken 1977). Fry and YOY are widely distributed throughout the bay, but are especially abundant in the western portion and around Johnson Island (41°30', 82°44') (Chapman 1955; Gehres and Scholl 1969; Hartley and Herdendorf 1975; Keller 1964a; Rudolph and Scholl 1970). In 1964, the area from Sandusky Bay eastward to Vermilion (41°26', 82°22') had one of the highest concentrations of fry in May (Baker 1965).

O-2

Huron River (41°24', 82°33'). Two spawning runs of gizzard shad, possibly from separate populations, enter the river; one run occurs from mid-June to early July and a second one from late July to early August. Large adults return to Lake Erie immediately after spawning; smaller adults remain in the river for a longer period (White, pers. comm. 1979). Large numbers of YOY were collected in the river in late summer (USDI 1967). Immense schools of young were found in the lower river, and densities were high as far as 5 mi upstream. Young-of-the-year were most abundant in late June (Cleveland Environ. Res. Group, undated). In the fall, YOY were found in the lake off the river. Large schools of YOY were present at night around the breakwalls and along the beaches (White, pers. comm. 1979; White et al. 1975). The abundance of fry and YOY in this area during July-October indicates that it is a nursery area (Wolfert et al. 1978).

Erie Power Plant site (41°23', 82°30'). In 1974, many young larvae were collected in June and July; they were most abundant on July 10 in water less than 10 ft deep. The shallow shoreline areas and tributary mouths may be nursery areas. Spawning probably occurs in this area during June and July at water temperatures of about 60-75°F (Ohio Edison 1977).

Vermilion River (41°26', 82°22'). Large numbers of newly hatched fry were collected in the river in July, just upstream from the mouth, and also in the harbor, indicating that large numbers of gizzard shad spawn in the area (Cleveland Environ. Res. Group 1975; U.S. Army Eng. Dist., Buffalo 1976a; USDI 1967). In 1964, the area between Vermilion and Sandusky Bay (41°29', 82°46') had one of the highest concentrations of fry in May (Baker 1965).

Beaver Creek (41°26', 82°15'). In 1979, eggs and postlarvae were collected to the 36 ft depth contour. Young-of-the-year were collected in trawls off the creek mouth in August and in seines at Oak Point Beach near the creek mouth in July (Commonw. Assoc. 1979).

Black River (41°28', 82°11'). Two separate spawning runs enter the river, possibly from separate populations; one run enters from mid-June to early July and the other enters from late July to early August (White, pers. comm. 1979). Larvae are abundant after late June in Lorain Harbor (Geo-Marine 1978).

Avon Lake Generating Station (41°30', 82°03'). Gizzard shad larvae were entrained during June and July; they were 15% of the total larvae entrainment during the summer (Applied Biology 1979c).

Rocky River (41°30', 81°50'). Two separate spawning runs enter the river, possibly from separate populations, from mid-June to early July and from late July to early August (White, pers. comm. 1979); YOY were collected in the river (White et al. 1975).

Cleveland Harbor (41°31', 81°42'). In 1960-62 and 1972, fry or YOY were abundant in Cleveland Harbor (White et al. 1975; Woner 1963). In 1975, most of the adults had migrated from the area before spawning and only a few fry were found. Successful spawning appeared to be concentrated west of Cleveland (41°30', 81°43'). Adults migrated from the Cleveland area by early May; presumably they moved toward the western end of the lake where they spawned and spent the summer. Young-of-the-year were much more abundant in the western part of the central basin than near Cleveland, Ashtabula (41°55', 80°47'), or Conneaut (41°58', 80°33'), where spawning was minimal. Adults and YOY migrated to the Cleveland area during late fall, where they overwintered (Caroots 1976). In 1977-78, gizzard shad larvae were the second most abundant larvae (27% of the total) entrained at the Lakeshore Generating Station (41°32', 81°38'). Gizzard shad larvae were most abundant in the vicinity of the station in July (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). Gizzard shad migrate upstream to spawn. Several runs occurred from mid-May to late August. Peak production of larvae occurs in late June in the quiet, shallow backwaters about 4 ft deep. Spawning also occurs on beaches near the river mouth, over partially vegetated substrate (probably in Cladophora) where larvae are collected (Environ. Resour. Assoc. 1978). At least two separate runs, possibly from different populations, enter the river; one run occurs from mid-June to early July, and another from late July to early August (White, pers. comm. 1979). In 1977-78, gizzard shad larvae were entrained at the Eastlake Plant (41°40', 81°27'); gizzard shad larvae were most abundant from mid-April to mid-June when they were 2% of the larvae entrained (Applied Biology 1979b).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, prolarvae and early postlarvae were present near the plant. Juveniles 1.1-2.6 in. long that had probably migrated from other areas were numerous near shore in late July and August (NUS 1975).

Ashtabula Harbor (41°55', 80°47'). Significant production of larvae occurs in the harbor and the river (Hubbard 1977, as cited in Sweeney 1978; Odin 1979). Gizzard shad larvae were 6% of the total larval catch in the lake at Ashtabula in late June to late August (Applied Biology 1979d,e).

Conneaut (41°58', 80°33'). Adults migrate into the river to spawn. In 1977, YOY were collected in the river from May to July, they migrated out of the river in late summer and reentered the river in the fall. In 1961, 1962, and 1977, YOY were collected in Conneaut Harbor; larvae were collected offshore in the lake between Conneaut Harbor and Raccoon Creek (41°59', 80°29') (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Raccoon Creek (41°59', 80°29'). Adults migrated into the creek to spawn; YOY migrated out of the creek in late summer and reentered the creek in the fall (Aquat. Ecol. Assoc. 1978).

Elk Creek (42°01', 80°22'). In 1974, larvae were abundant in June and July in the lake off the creek (GPU Serv. Corp. 1979).

Presque Isle Bay (42°08', 80°07'). Spawning adults were seen in the bay in 1-2 ft of water over sand and mud bottom with submergent vegetation, filamentous algae, and detritus. Spawning adults were also observed in the shallows of Presque Isle (42°10', 80°06') among submergent and emergent vegetation over mucky bottom, where the water was clear and there was little current. Young-of-the-year were collected where spawning adults were observed (Kenyon, pers. comm. 1979).

New York

Van Buren Bay (42°27', 79°25'). Prolarvae, postlarvae, and YOY were found here in June, from mid-May to early August, and September respectively (Envirosphere 1977a; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Canadaway Creek (42°28', 79°22'). Young-of-the-year were collected along shore near the creek over rock bottom in 1-4 ft of water in July and August (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 79°20'). This was identified as a major nursery area; YOY were collected in the harbor throughout the spring and summer, over rock at a depth of 2-4 ft (Griswold and Galati, pers. comm. 1979). In 1976, gizzard shad postlarvae were one of the most abundant postlarvae present, near the lake bottom in July and August. The presence of gravid, ripe, and spent fish in the harbor suggests spawning occurs there (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). In 1976, prolarvae were entrained at the Dunkirk Steam Station (42°30', 79°21') in June; postlarvae were entrained there in June-August (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14'). Prolarvae and postlarvae were collected in the bay in May-July, suggesting that the bay is a spawning area (Envirosphere 1977a; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a). Young-of-the-year were collected in July to September suggesting that it is a nursery area (Griswold and Galati, pers. comm. 1979; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Ripe gizzard shad were caught along the east side of Pottohawk Point (42°37', 80°17'), to a depth of about 14 ft; YOY were also captured there along shore (Whillans, pers. comm. 1979). In 1974, larvae and YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in June to August. In 1976, larvae and YOY were caught in shore seines in July to September near the station. Peak entrainment of YOY occurred in late July and early August; YOY alewives were more abundant than those of other species collected in shore seines at that time (Chamberlain 1976; Hamley and MacLean 1979; Teleki 1976).

CLUPEID spp.

Michigan

In the latter part of the spawning season, most hatching seems to occur in or near the tributaries along the western shore. The larvae do not avoid surface waters and in a short time are dispersed widely from spawning areas and are abundant all along the western shore (Cole 1978a,b).

Swan Creek (41°58', 83°15'). In 1975-76, the highest density of clupeid larvae in Michigan waters of the lake was recorded in an area (41°59', 83°14') just north of the creek mouth in late June (Waybrant and Shauver 1979).

Monroe (41°55', 83°24'). In 1973-75, clupeid larvae were more abundant than those of other species near the Monroe Power Plant (41°53', 83°21') in June and July (MacMillan 1976). In 1975, clupeid eggs and larvae were entrained at the plant in May and June (Detroit Edison 1976b). In 1974 and 1975, clupeid larvae were collected near the mouth of the Raisin River (41°53', 83°20') and in the plant discharge canal (41°53', 83°21') (Cole 1976). Larvae were usually more abundant nearshore and probably either hatched near the plant or drifted into the area from Maumee Bay (41°43', 83°25') (Cole 1978b; MacMillan 1976). Larvae were consistently found in the plant's discharge canal before they appeared in the intake canal; hatching may have occurred in the canal (Cole 1978b; MacMillan 1976).

Woodtick Peninsula (41°44', 83°25'). In 1975 and 1976, high densities of clupeid larvae were found at depths of 6-12 ft off the peninsula in June and were more abundant here than elsewhere in the Michigan waters of the lake (Waybrant and Shauver 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). The bay may be a major spawning area early in the season (Cole 1978a,b).

O-2

Beaver Creek (41°26', 82°15'). Sampling conducted near the mouth of the creek revealed the presence of clupeid eggs in June to early July, prolarvae in late May to early July, postlarvae in late May to September, and juveniles in August and September (Commonw. Assoc. 1979).

MOONEYE

Mooneyes spawn in Lake Erie primarily in April to early June (Fish 1932; Johnson 1951).

Ohio

O-1

Maumee Bay (41°43', 83°25'). In 1929, a few larvae were found off the mouth of the river (Fish 1932). In 1975, larvae were collected in mid-Maumee Bay near the navigation channel in May (Herdendorf and Cooper 1977).

Sandusky Bay (41°29', 82°46'). In 1961, small numbers of young-of-the-year were captured in western Sandusky Bay in May-October (Keller 1964a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Until the late 1940s or early 1950s, spawning runs entered Big Creek (42°36', 80°27') (Whillans, pers. comm. 1979).

OE-5

Grand River (42°51', 79°35'). Spawning runs still enter the river (Whillans, pers. comm. 1979).

LONGJAW CISCO

No longjaw cisco have been taken in Lake Erie since 1957 (Hartman 1972).

Ontario

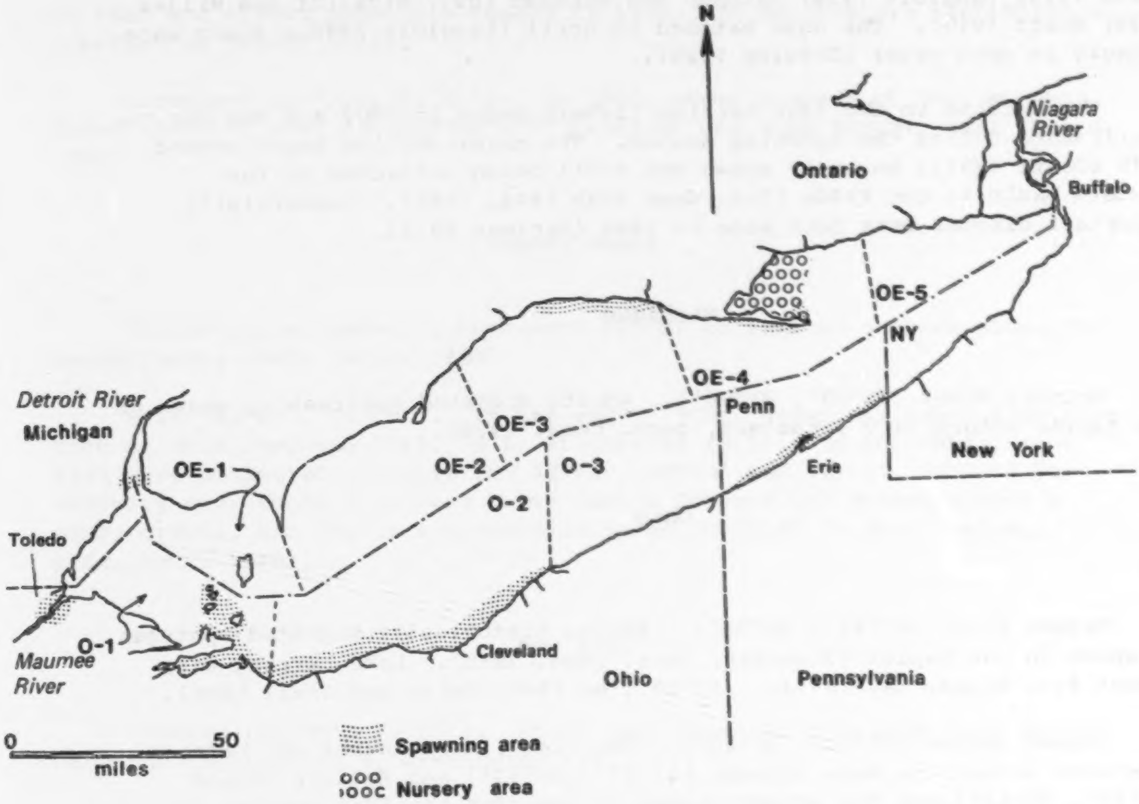
OE-4

Long Point Bay (42°40', 80°10'). Individuals taken at Port Dover (42°47', 80°12') in November 1920 were almost ready to spawn (Clemens 1922). All fish taken November 11, 1957, near Long Point (42°33', 80°10') were ripe; one male collected November 13 appeared partly spent (Scott and Smith 1962).

OE-5

Grand River (42°51', 79°35'). Individuals taken upstream at Dunnville in November 1920 were almost ready to spawn (Clemens 1922).

LAKE HERRING


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
OE-2
O-3
O-2
Erie
New York
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Lake herring migrated from the deeper waters of the eastern portion of the lake, such as the deep hole off Long Point (42°33', 80°10'), to spawn in shallow water in the western basin (Hile, pers. comm. 1979; Langlois 1948, 1954; Moore 1894; Rathbun and Wakeham 1897; Scott 1951; Trautman, pers. comm. 1979; Wickliff 1936). It was also hypothesized, however, that herring did not migrate from one end of the lake to the other but that the stock was composed of several races (Koelz 1926). Historically, the run began on the Canadian shore near Rondeau (42°15', 81°53') and was more pronounced along the shores west of Point Pelee (41°55', 82°30') and Vermilion (41°26', 82°22'). The run along the southern shore of the central basin was believed to be ill-defined, because it was so obstructed by gillnets that the fish had to move along the Canadian shore until deflected southward by Point Pelee (Rathbun and Wakeham 1897). A part of the run continued south to Kelleys Island (41°36', 82°42'), Huron (41°24', 82°33'), and Vermilion; another portion passed around Point Pelee and spread out over the area west of the islands (Moore 1894). A large number also moved up into the Detroit River

(42°03', 83°08') (MSBFC 1895). The migration began as early as late September. Spawning occurred in open water over all bottom types, mainly between mid-November and early December; the fish returned to the east in December (Bean 1915; Fish 1929; Greeley 1929; Kerr and Kerr 1860-1898; Koelz 1929; Langlois 1954; Rathbun and Wakeham 1897; Wickliff and Miller 1929; Scott 1950). The eggs hatched in April (Langlois 1948); young were pelagic in open water (Greeley 1929).

The decline in the lake herring fishery began in 1902 and was due to overfishing during the spawning season. The major decline began around 1925 (Scott 1951); however, spawn was still being collected in the western basin in the 1940s (Ont. Game Fish 1944, 1945). Commercially important catches were last made in 1946 (Hartman 1972).

Michigan

Detroit River (42°03', 83°08'). Adults migrated upstream to spawn on the rapids before 1900 (Trautman, pers. comm. 1979).

Ohio

O-1

Maumee River (41°41', 83°28'). Adults historically migrated upstream to spawn on the rapids (Trautman, pers. comm. 1979). Lake herring were absent from Maumee Bay (41°43', 83°25') by 1885 (Smith and Snell 1891).

Island Region (41°40', 82°45'). The clean, hard gravel and bedrock substrate around the Bass Islands (41°41', 82°49') and Kelleys Island (41°36', 82°42') was the primary spawning area for the lake herring in Lake Erie. The heaviest run occurred in November and reached a peak on the west side of the islands approximately 2 weeks later than on the east side. This area was degraded by siltation as early as 1881, and by the early 1890s its use by herring had decreased (Langlois 1954; Moore 1894; Smith and Snell 1891; Trautman 1957, pers. comm. 1979). In 1889, many eggs were found in January in the stomachs of mud puppies captured in Put-In-Bay (41°39', 82°49') (Stranahan 1898).

Sandusky Bay (41°29', 82°46'). Lake herring were fished here for about 60 days during the fall (Klippart 1877). Large catches occurred over sand bottom from Cedar Point (41°29', 82°41') to a location 6 mi E, and from Sugar Bluff (possibly Sugar Rock at 41°34', 82°51') to the bay entrance (Kumlien and True 1887).

O-2

Historically, lake herring spawned along the Ohio shore of the central basin as far east as Fairport (41°46', 81°17') (Rathbun and Wakeham 1897). Heavy runs occurred in mid-November in the Cedar Point (41°29', 82°41')--Avon Point (41°31', 82°01') region (Moore 1894).

Huron (41°24', 82°33'). This area had the most favorable fishery on the lake. Lake herring were caught as they passed into the western basin and were also taken on a large spawning ground that extended 5 mi E and W of Huron (Kumlien and True 1887). More than 1 million pounds were taken in 1885 and almost none were caught in 1894; the decline was attributed to overfishing (MSBFC 1895).

Cleveland (41°30', 81°43'). In 1893, great numbers of herring were found spawning over mud bottom off Cleveland and even farther east (Moore 1894).

Pennsylvania

Historically, spawning fish were caught in limited numbers along the Pennsylvania shore (Moore 1894).

Erie (42°07', 80°05'). In the early 1900s, spawn was taken from ripe fish at Erie (Redband 1912, 1913; Winchester 1915). In the 1950s, ripe fish were collected off Erie (at 42°12', 80°15' and 42°17', 80°00') for hatchery use; these fish were taken during October and November over a sand, gravel, and rubble substrate in water about 60 ft deep (Larsen, pers. comm. 1979).

New York

Dunkirk (42°29', 79°20'). Spawn was collected from ripe fish during December (Redband 1913; Winchester 1912).

Ontario

OE-2

Kent County (42°04', 82°27'--42°27', 81°40'). In 1912, catches were plentiful by mid-October (Scott 1951); catches were still large in 1913 (Ont. Game Fish 1915).

OE-3

Port Stanley (42°39', 81°13')--Port Burwell (42°37', 80°48'). During the spawning season adults congregated inshore between Port Stanley and Port Burwell (Scott 1950, 1951). Fishing was still good in 1912, and spawn was still being taken in 1915 at Port Stanley (Ont. Game Fish 1913a; Rodd 1917; Scott 1951). Historically, the spawning run at Port Stanley began on about October 20 (Kerr and Kerr 1860-1898), and spawning occurred in November (Jordan and Evermann 1911).

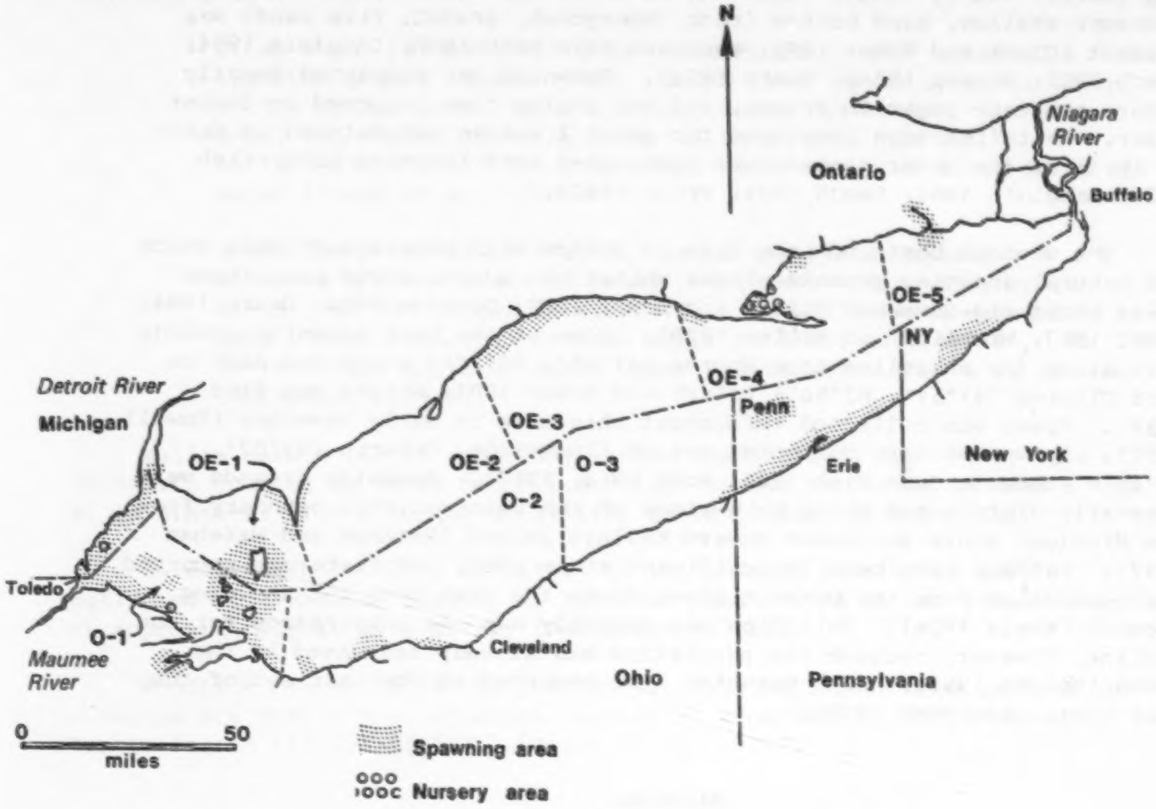
OE-4

Long Point Bay (42°40', 80°10'). Lake herring spawned on the east and west sides of Bluff Bar (42°35', 80°09'), along the south shore of Long Point (42°33', 80°10') and possibly north of Turkey Point (42°39', 80°21'). There are no spawning records for the bay itself, but the bay served as a nursery area at least until 1894 (Whillans 1977, pers. comm. 1979). In 1911, large catches were still being made at Port Dover (42°47', 80°12') in December (Scott 1951).

OE-5

Port Maitland (42°51', 79°35'). Historically, enormous catches were made here in December (Kerr and Kerr 1860-1898; Ont. Game Fish 1912; Scott 1951).

LAKE WHITEFISH


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
OE-2
O-3
O-2
Erie
New York
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Historically, on about the first of October, lake whitefish began to migrate from the eastern basin of Lake Erie along both the north and south shores to the rocky shoals at the western end of the lake to spawn (Cole 1905; Downing 1904, 1910; Ferguson 1957; Kerr and Kerr 1860-1898; Kumlien and True 1887; Leach 1923; Milner 1874b; Moore 1894; Rathbun and Wakeham 1897; Smith and Snell 1891; Trautman 1957; Wright 1955). Lake whitefish are believed to have moved clockwise around the lake on their spawning migration, often passing to the west through the islands area and back along the Canadian shore (Wolfert, pers. comm. 1979). Lake whitefish passed through the western basin and into the Detroit River and, until the early 1900s, into Lake St. Clair and the St. Clair River to spawn; they returned via Pigeon Bay (42°00', 82°40') which borders Point Pelee on the west (Kerr and Kerr 1860-1898; Keyes 1894; Milner 1874c; MSBFC 1887, 1895; Reighard 1910; Trautman 1957). In Lake Erie, lake whitefish spawned for 18-60 days in late October to December when temperatures were generally 43-53°F (Fish 1929; Kerr 1874; Klippart 1877; Koelz 1929; Langlois 1945b, 1954; Milner 1874a; Price 1940; Rathbun and Wakeham 1897; Stockwell 1875a; Van Oosten and Hile 1949; Wickliff 1928b, 1933a, 1936, 1957; Wickliff and Miller 1929). Spawning usually does not begin until the temperature drops to at least 46°F (Lawler 1965).

Spawning has been reported to occur from November 10 to December 10 in the east end of the lake and from November 15 to December 15 in the west end (MacKay 1957f, 1969). Spawning occurred throughout the western basin wherever shallow, hard bottom (rock, honeycomb, gravel, firm sand) was present (Clark and Bower 1883; Kerr and Kerr 1860-1898; Langlois 1954; Leach 1923; Milner 1874b; Moore 1894). Spawning was completed shortly before the lake began to freeze, and the adults then returned to deeper water. Whitefish eggs developed for about 4 months and hatched in March or April as the water temperature approached 43°F (Downing 1904; Fish 1929; Langlois 1954; Leach 1923; Price 1940).

The western basin of Lake Erie is dotted with shoals and reefs which are natural spawning grounds of the whitefish; adults moved into these areas about mid-November (Clark and Bower 1883; Downing 1904; Geare 1884; MSBFC 1887; Wickliff and Miller 1929). Some of the best spawning grounds were along the shoreline from Monroe (41°55', 83°20') south and east to Port Clinton (41°31', 82°56') (Clark and Bower 1883; Wright and Tidd 1933). Spawn was collected throughout this area in early November (Howell 1882). Spawn was also collected out of Kingsville, Ontario (42°02', 82°44') (Ontario Game Fish 1943; Rodd 1914, 1917). Spawning grounds were generally distributed along both sides of the international boundary from the Michigan shore southeast toward Kelleys Island (Rathbun and Wakeham 1897). Catches have been insignificant since 1920, and fishermen reported that pollution from the Detroit River drove the fish from the spawning grounds (Koelz 1926). Pollution was probably not the only reason for the decline, however, because the population had already decreased by the 1890s (Wright 1955). Some spawning also occurred at the east end of the lake (Ont. Game Fish 1945).

Michigan

Pointe Mouillee (42°01', 83°12'). Spawning occurred in an area (42°00', 83°09') about 3 mi E of Pointe Mouillee over clay bottom at depths of about 10-15 ft (Organ et al. 1978).

Point aux Peaux (41°57', 83°15'). Lake whitefish spawn along the shoreline from Point aux Peaux south to Stony Point (41°56', 83°16') in 2-12 ft of water. Since 1911, spawning has also occurred 2-3 mi E of Point aux Peaux (at 41°57', 83°13') over clay bottom in about 18 ft of water (Organ et al. 1978).

Stony Point (41°56',83°16')--Plum Creek (41°54', 83°23'). Until the 1940s, spawning occurred along this shoreline at depths of 18-20 ft (Organ et al. 1978). From 1900-13, the entire area produced considerable amounts of spawn for hatchery use, but by 1919 no eggs could be collected. The decline occurred after large powder factories were established at Monroe (41°55', 83°24') and began dumping refuse into the lake (Clark 1886; Downing 1923; Langlois 1941; Wright and Tidd 1933). However, spawning may have been reduced in the area before the turn of the century; fish caught there during mid-November to mid-December rarely weighed more than 1 lb (Smith and Snell 1891).

> Stony Point (41°56', 83°16'). Historically, this area was a spawning ground (Lyons 1972). Since 1911, spawning occurred on a clay bottom area 1 mi S of Stony Point (at 41°55', 83°16'); until the 1940s, spawning occurred in an area (41°54', 83°14'--41°57', 83°13') 2 mi SE of Stony Point in about 20 ft of water (Organ et al. 1978).
>
> Sandy Creek (41°56', 83°20'). Until the 1930s, spawning occurred off the mouth of Sandy Creek in 6-12 ft of water at 41°55', 83°19' (Organ et al. 1978). In 1977, small numbers of larvae were collected in late April in Brest Bay (41°55', 83°18') just north of Sandy Creek out to about the 14 ft contour (Patterson 1979a).

Bolles Harbor (41°51', 83°24'). From the 1900s to the 1940s, lake whitefish spawned in 16-24 ft of water east of the harbor in an area 3 1/2 mi in diameter with a center at 41°51', 83°18' (Organ et al. 1978).

Toledo Beach (41°50', 83°24'). In 1977, early postlarvae were collected at a maximum density of 7/100 m^3 about 2-1/4 mi off Toledo Beach at approximately 41°49', 83°22' (Patterson 1979a).

Woodtick Peninsula (41°44', 83°25'). Lake whitefish have spawned in a narrow arc within 5 mi of shore, extending from 41°49', 83°24' south to Turtle Island (41°45', 83°23') (Organ et al. 1978).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Lake whitefish spawned in Maumee Bay until 1885-1890. The population declined drastically in about 1900, possibly due to smothering of the spawning beds in the bay and other areas of the western basin by the heavy silt load entering from the Maumee River (41°41', 83°28') (GLBC 1975; Pinsak and Meyer 1976; Smith 1969; Smith and Snell 1891; Trautman 1957; USDI 1967; Wright 1955). Many fish, however, were still taken at this time east of Cedar Point (41°42', 83°20') during the spawning season (Smith and Snell 1891). Presently spawning occurs from November 15 to December 1 in a gravel area 2 mi E of the Maumee River mouth, at 41°42', 83°15' (Pinsak and Meyer 1976).

Locust Point (41°36', 83°05'). Spawning occurred between Locust Point and Port Clinton (41°31', 82°56') (Smith and Snell 1891); a spawn collection station was located at Toussaint River (41°35', 83°04') (Clark 1886). In 1848, a storm drove many lake whitefish eggs onto Ottawa Beach (precise location unknown; probably near 41°32', 83°00') (Goode 1884). Spawning may still be occurring near Locust Point. In 1978, prolarvae in small densities were found on April 30 at the intake of the Davis-Besse Power Station (41°36', 83°04') (Reutter 1979c).

Niagara Reef (41°40', 82°58'). In the late 1800s, the reef was a well-known spawning area for lake whitefish (Rathbun and Wakeham 1897); the run was fished in late October to early December (Smith and Snell 1891). Good spawning runs were still entering the area between 1940 and 1955, but the reef areas are now silted over and the runs have ceased (Trautman 1957, pers. comm. 1979).

West Sister Island (41°44', 83°06'). This area was an excellent spawning ground (Geare 1884). West Sister Island is presently a spawning area (Trautman 1957, pers. comm. 1979). Spawning was recently observed and eggs were collected in 5-15 ft of water over gravelly rock November 20 to December 1 (Reynolds, pers. comm. 1979).

Green Island (41°39', 82°52'). Lake whitefish spawned in 4-20 ft or more of water over reefs and rocky shore areas surrounding the island (Rathbun and Wakeham 1897).

Rattlesnake Island (41°41', 82°51'). The reefs and rocky shores around Rattlesnake Island were a well-known spawning area (Rathbun and Wakeham 1897).

Bass Islands (41°41', 82°49'). Historically, spawning occurred in the islands (Langlois 1941). In 1880, eggs were collected around the islands (Berst and Spangler 1970a); spawn collection stations were located at North Bass Island (41°43', 82°49'), and Put-In-Bay (41°39', 82°49') (Clark 1886). In 1933, most of the lake whitefish eggs that were collected from western Lake Erie came from the Bass Island area (Wright and Tidd 1933). Good runs of spawners were still arriving at the Bass Islands between 1939 and 1955 (Trautman, pers. comm. 1979).

> North Bass Island (41°43', 82°49') and Middle Bass Island (41°41', 82°49'). The honeycombed reefs and rocky shores around these islands were some of the best known spawning grounds in Lake Erie (Rathbun and Wakeham 1897; Smith and Snell 1891). The best areas extended 3-1/2 mi off the west side of North Bass Island and from the north side of North Bass Island to the Hen and Chickens (41°47', 82°48') islands (True 1884; Kumlien and True 1887; Smith and Snell 1891). Spawning was recently observed and eggs were collected in 5-15 ft of water during November 20-December 1 over the rock and gravel reef off the west shore of North Bass Island (Reynolds, pers. comm. 1979).
>
> South Bass Island (41°39', 82°50'). In 1897, lake whitefish eggs were found in the stomachs of mud puppies collected at Put-In-Bay (41°39', 82°49') in January (Stranahan 1898).

Kelleys Island (41°36', 82°42'). Some of the best known spawning areas were the two shoals north of Kelleys Island in 4-20 ft of water (Geare 1884; Kumlien and True 1887; Rathbun and Wakeham 1897). These shoals were probably Kelleys Island Shoal (41°38', 82°39') and Gull Island Shoal (41°40', 82°41'). The spawning run began here 7-10 days earlier than at the other islands (Smith and Snell 1891). In 1933, lake whitefish eggs were collected here for hatchery use (Sterling 1876; Wright and Tidd 1933). Historically, Kelleys Island was an important spawning area. The peak of the spawning run occurred in late November (Wolfert, pers. comm. 1979). Lake whitefish are presently found on Kelleys Island Shoal in late fall (ODNR, undated). Spawning has been observed and eggs were collected in 5-15 ft of water in late November to December (Reynolds, pers. comm. 1979).

Gull Island Shoal (41°40', 82°41'). This is considered to be a major spawning area. Eggs were collected and spawning lake whitefish were observed November 20 to December 1 over gravel rock in 5-15 ft depths (Reynolds, pers. comm. 1979).

Sandusky (41°27', 82°42'). In 1872, ripe and spent fish were caught in November and December; eggs were collected on about October 1 for the Sandusky hatchery. Spawning occurred in this area over rocks and reefs (Howe 1907; Milner 1874a,c; Van Oosten and Hile 1949). Very large catches were made at East Harbor (41°32', 82°47') when pound nets were first used in 1850-51 (Klippart 1877), and a spawn collection station was located at Catawaba Island (41°35', 82°51'). It was reported that "Otsego bass" (probably lake whitefish) once migrated up the Sandusky River to spawn at Fremont (Van Oosten 1926).

O-2

Huron (41°24', 82°33'). Adults moved past Huron to spawning grounds and returned in early winter (Kumlien and True 1887; Smith and Snell 1891).

Chappel Creek (41°24', 82°27'). Spawning occurred on a small rocky area 5 mi E of Huron (Kumlien and True 1887); this is the approximate location of Chappel Creek. There is presently a rocky area about 1 mi off the creek mouth at 41°24', 82°28'.

Lorain (41°28', 82°11'). Collections of ripe fish were made off Lorain during the spawning season (Van Oosten and Hile 1949). In 1979, one prolarva was collected on April 19 in 36 ft of water at approximately 41°27', 82°17'; a second prolarva was taken on May 10 in 23 ft of water off Beaver Creek at approximately 41°26', 82°15'. There is no recorded presence of adults in these areas during the previous fall (Commonw. Assoc. 1979).

Dover Bay (exact location unknown). This lake whitefish spawning ground was 13-14 mi W of Cleveland (41°30', 81°43'), and was the closest such ground to Cleveland (Sterling 1883). A small rock reef (location unknown) between Dover Bay and Lorain (41°28', 82°11') was also used for spawning (Geare 1884).

O-3

Fairport (41°46', 81°17'). Many lake whitefish were taken during the spawning season at an unspecified location several miles east of Fairport (Geare 1884).

Conneaut (41°58', 80°33'). Ripe fish were taken during spawning runs in November; limited spawning occurred on the rocky shore off Conneaut (Smith and Snell 1891).

Pennsylvania

Historically, lake whitefish spawned along the Pennsylvania shore in mid-November (Moore 1894).

Elk Creek (42°01', 80°22'). Historically, spawning occurred in the lake off the creek (Smith and Snell 1891).

Northwest Sand Bar (42°19', 80°20'). This is probably a spawning area for lake whitefish. The area has an unstable sand bottom with no vegetation and is 48-66 ft deep. In the late fall, lake whitefish concentrate in the area; gravid females and males with running milt have been collected here as late as mid-November. Spawning probably occurs in less than 60 ft of water (Kenyon, pers. comm. 1979).

Erie (42°07', 80°05'). In the early 1900s, spawn was collected near Erie (Redband 1912). In the 1950s, ripe adults for hatchery use were also collected off Erie at 42°12', 80°15' and 42°17', 80°00' and just east of Walnut Creek (42°04', 80°14') in about 60 ft of water over sand, rubble, and gravel in October and November (Larsen, pers. comm. 1979).

New York

Dunkirk (42°29', 79°20'). Historically, a small spawning ground existed between Dunkirk and Westfield (42°19', 79°35'). In the 1890s, spawning fish were taken here as late as January 1 (Moore 1894).

Ontario

In the early 1900s, most lake whitefish were believed to spawn along the Canadian shore because pollution along the U.S. shore prevented spawning there (Reighard 1913).

OE-1

Hen and Chick Island Reef (41°47', 82°48'). Whitefish spawned in 4-20 ft of water over the reef areas (Rathbun and Wakeham 1897).

Pelee Island (41°47', 82°40'). In the 1920s, Pelee Island was a whitefish spawning ground and was historically the best fishing ground in the lake. Much spawn was collected for hatchery use. Whitefish spawned on Pelee Island reefs in less than 30 ft of water from November 20 into December. The substrate in this area is honeycombed limestone rock or gravel (Ferguson 1957; Kerr and Kerr 1860-1898; Koelz 1929; Rodd 1919). Much of the remnant lake whitefish population spawns around the island (Ferguson 1957).

Point Pelee (41°55', 82°30'). Much of the remnant lake whitefish population spawns at Point Pelee (Ferguson 1957).

OE-2

Kent County (42°04', 82°27'--42°27', 81°40'). In 1912, large catches were reported in the fall along this shoreline (Ont. Game Fish 1913a).

OE-3

Port Burwell (42°37', 80°48'). Historically, spawning occurred offshore (Rathbun and Wakeham 1897); spawners were plentiful on about October 1 along the shoreline of Elgin County (42°37', 80°43'--42°27', 81°40') (Ont. Game Fish 1913a).

OE-4

Clear Creek (42°34', 80°35'). Adults were caught here in November (Kerr and Kerr 1860-1898); the area (42°33', 80°41') just west of Clear Creek, at depths of 36-48 ft is presently a spawning area (Environ. Can. 1977a).

Long Point Bay (42°40', 80°10'). Until 1888, lake whitefish spawned at Inner and Outer Turkey Point (42°39', 80°21') on reefs within 1 mi of shore. Ripe adults were caught on the east and west sides of Bluff Bar (42°35', 80°09') on Long Point (42°33', 80°10') (Whillans, pers. comm. 1979). There is also evidence that Inner Bay (42°37', 80°22') was a nursery area for lake whitefish (Whillans 1977).

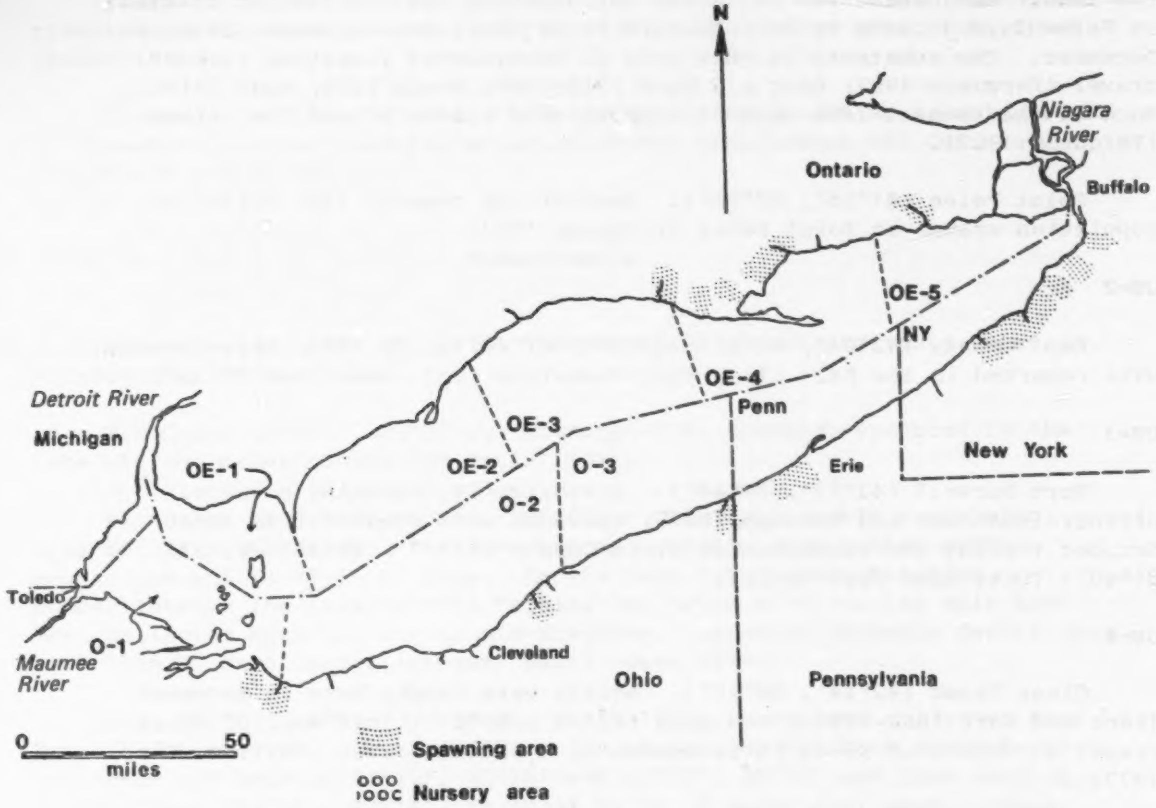
Port Dover (42°47', 80°12'). A spawning ground existed offshore (Rathbun and Wakeham 1897), and spawn was collected there from ripe fish (Ont. Game Fish 1943).

Nanticoke (42°48', 80°04'). Spawn was collected in this area (Ont. Game Fish 1911, 1912; Vokes 1912).

OE-5

Port Maitland (42°51', 79°35'). Spawning occurred offshore (Koelz 1929). Spawn also was collected from ripe fish in the Grand River at Dunnville (Rodd 1914). Adults were plentiful during fall off Haldimand County (42°47', 80°06'--42°52', 79°26'), and large quantities of spawn were taken (Ont. Game Fish 1913b, 1915).

COHO SALMON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Niagara River
Ontario
Buffalo
OE-5
NY
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Penn
Detroit River
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OE-1
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O-3
New York
Erie
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In 1933, coho salmon fingerlings were stocked in Pickerel (41°26', 82°57') and Cold (41°27', 82°46') creeks, tributaries of Sandusky Bay; these plantings were unsuccessful (Parsons 1973). Annual plantings began in Ohio, Pennsylvania, and New York waters of Lake Erie in 1969 and in Michigan waters in 1974 (GLFC 1973a,b, 1975, 1976, 1978 in press; NYDEC 1977a; ODNR, undated). Spawning runs have developed in several tributaries, primarily in the eastern and central basins, but little natural reproduction occurs.

Significant numbers of coho salmon are observed during September of each year, when they school near stream mouths (Shea 1972). An annual clockwise migration occurs between the eastern and central basins. In January and February, juvenile coho salmon concentrate near warm water discharges at Lorain (41°28', 82°11') and Cleveland (41°30', 81°43'), in May-August they concentrate between Point Pelee (41°55', 82°30') and Port Stanley (42°39', 81°13'), and in September and October, as adults, they move back to their home streams (Baker and Scholl 1971c; Shea 1972). Spawning runs enter a number of Lake Erie tributaries.

Ohio

O-1

Cold Creek (41°27', 82°46'). Spawning runs were documented in 1969 and 1970 (Baker and Scholl 1971c).

O-2

Huron River (41°24', 82°33'). In 1969-71, coho salmon from plantings made in 1968-70 entered the river. The run began in the second week of September at a water temperature of 72°F (Baker and Scholl 1971c).

Avon Lake Generating Station (41°30', 82°03'). In 1974, ripe and sexually mature coho were taken in October near the station; these fish may have been migrating to nearby streams to spawn (Aquat. Ecol. Assoc. 1975).

Chagrin River (41°41', 81°26'). In 1969-71, coho salmon from plantings made in 1968-70 entered the river. The run began in the second week of September, at a water temperature of 67°F (Baker and Scholl 1971c). Large runs presently occur (Environ. Resour. Assoc. 1978).

O-3

Conneaut (41°58', 80°33'). The spawning run enters the Conneaut River in the second week of September, when the water temperature is 67°F, and peaks in October (Baker and Scholl 1971c). In 1977, a fall migration of coho was observed nearshore at Conneaut. In 1977, three ripe adults were collected from Turkey Creek (41°58', 80°32') during September and October (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22') (Moccia, pers. comm. 1979). Adults are found near the creek mouth beginning in September, but little reproduction occurs (GPU Serv. Corp. 1979; U.S. Army Eng. Dist. 1973).

Trout Run (42°03', 80°16') (Knuth 1976; Moccia, pers. comm. 1979).

Walnut Creek (42°04', 80°14') (Moccia, pers. comm. 1979).

New York

Canadaway Creek (42°28', 79°22') and Scott Creek (42°30', 79°18') (NYDEC 1977b).

Beaver Creek (42°31', 79°17') and Walnut and Silver Creeks (42°33', 79°10') (NYDEC 1977b).

Cattaraugus Creek (42°34', 79°08'). Some natural reproduction occurs (GLFC 1977; NYDEC 1977a,b).

Delaware Creek (42°38', 79°04') (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Big Sister Creek (42°40', 79°04') (NYDEC 1977b).

Eighteenmile Creek (42°43', 78°58') (Buffalo Waterfront Devel. Comm., undated).

Athol Springs (42°46', 78°53') (NYDEC 1977b).

Ontario

OE-3

Big Otter Creek (42°37', 80°48'). (Environ. Can. 1977a; OMNR 1973).

OE-4

Clear Creek (42°34', 80°35') (Environ. Can. 1977a; OMNR 1973).

Big Creek (42°36', 80°27'). Runs enter Venison Creek (Environ. Can. 1977a; OMNR 1973). The coho salmon running into Inner Bay do not appear to be reproducing successfully (Whillans 1979b).

Potters Creek (42°43', 80°19') and Fishers Creek (42°43', 80°18') (OMNR 1973).

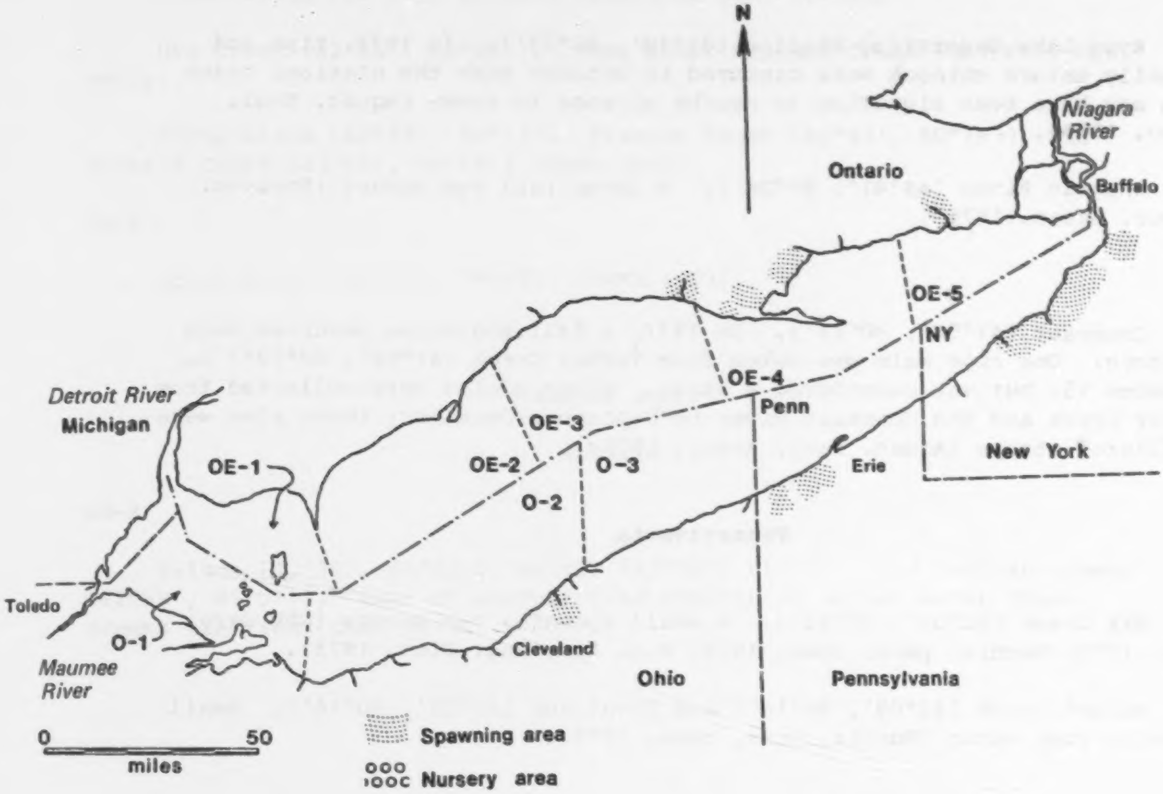
Young Creek (42°45', 80°15') (Kelso 1972; OMNR 1973).

Port Dover (42°47', 80°12'). Spawning runs enter three tributaries at Port Dover (Teleki 1975a).

OE-5

Grand River (42°51', 79°35') (Environ. Can. 1977a; OMNR 1973).

CHINOOK SALMON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New York
O-2
Toledo
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Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In 1873-80, chinook salmon fry were planted in Ohio tributaries to Lake Erie, mainly in the Maumee River, and also in five Michigan tributaries. In 1933, yearlings were planted in Pickerel (41°26', 82°57') and Cold (41°27', 82°46') creeks, tributaries of Sandusky Bay; only one survivor was reported (Parsons 1973). Plantings resumed in Ohio Waters in 1970, and were begun in Pennsylvania waters in 1971, and in Michigan and New York waters in 1973 (GLFC 1973a, 1975, 1976, 1978 in press; NYDEC 1977a). Spawning runs have developed in several tributaries, primarily in the eastern and central basins, but little natural reproduction occurs.

Significant numbers of chinook salmon are observed in September when they school near stream mouths (Shea 1972). An annual clockwise migration occurs between the eastern and central basins. In January and February chinook salmon concentrate near warm water discharges at Lorain (41°28', 82°11') and Cleveland (41°30', 81°43'), in May to August they concentrate between Point Pelee (41°55', 82°30') and Port Stanley (42°39', 81°13'), and in September and October, they move back to home streams (Shea 1972). Spawning runs enter a number of Lake Erie tributaries.

Ohio

O-2

Avon Lake Generating Station (41°30', 82°03'). In 1974, ripe and sexually mature chinook were captured in October near the station; these fish may have been migrating to nearby streams to spawn (Aquat. Ecol. Assoc. 1975).

Chagrin River (41°41', 81°26'). A large fall run occurs (Environ. Resour. Assoc. 1978).

O-3

Conneaut (41°58', 80°33'). In 1977, a fall migration occurred here offshore. One ripe male was taken from Turkey Creek (41°58', 80°32') on November 15, but was considered a stray. Other adults were collected from Turkey Creek and the Conneaut River in September-December; these also were considered strays (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22'). A small spawning run occurs (GPU Serv. Corp. 1979; Moccia, pers. comm. 1979; U.S. Army Eng. Dist. 1973).

Walnut Creek (42°04', 80°14') and Trout Run (42°03', 80°16'). Small spawning runs occur (Moccia, pers. comm. 1979).

New York

Canadaway Creek (42°28', 79°22'), Scott Creek (42°30', 79°18'), Beaver Creek (42°31', 79°17'), Walnut and Silver Creeks (42°33', 79°10'), and Cattaraugus Creek (42°34', 79°08') (NYDEC 1977b).

Delaware Creek (42°38', 79°04') and Big Sister Creek (42°40', 79°04'). Natural reproduction occurs (NYDEC 1977b).

Eighteenmile Creek (42°43', 78°58') (Buffalo Waterfront Devel. Comm., undated).

Athol Springs (42°46', 78°53') (NYDEC 1977b).

Ontario

OE-3

Big Otter Creek (42°37', 80°48') (Environ. Can. 1977a; OMNR 1973).

OE-4

Clear Creek (42°34', 80°35') (Environ. Can. 1977a).

Big Creek (42°36', 80°27'). Runs enter Venison Creek (Environ. Can. 1977a).

Young Creek (42°45', 80°15'), Fishers Creek (42°43', 80°18'), and Potters Creek (42°43', 80°19') (OMNR 1973).

OE-5

Grand River (42°51', 79°35') (OMNR 1973).

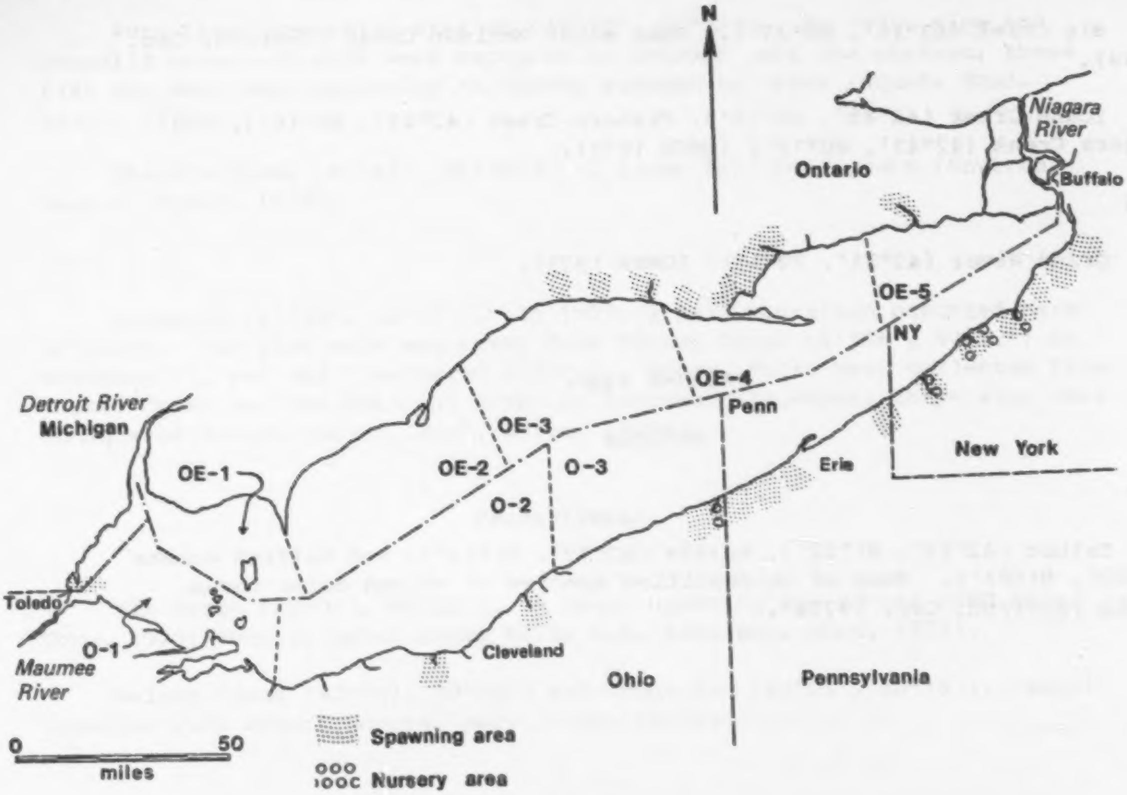
SALMON spp.

Ontario

OE-3

Talbot (42°38', 81°22'), Kettle (42°39', 81°13'), and Catfish creeks (42°39', 81°01'). Runs of unidentified species of salmon enter these creeks (Environ. Can. 1977a).

RAINBOW TROUT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New York
Erie
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

The initial plantings of rainbow trout in the Lake Erie watershed occurred in the Huron River (42°02', 83°12'), Michigan, in 1882. Plantings were made in Cold Creek (41°27', 82°46'), Ohio, in 1886, in Pennsylvania tributaries before 1895, and in Cattaraugus Creek (42°34' 79°08'), New York, in 1899. Rainbow trout were caught in the Pennsylvania waters of Lake Erie by 1895. Plantings by the Province of Ontario began in 1936. Continued stocking of rainbow trout (steelhead) has produced spawning runs in several tributaries of Lake Erie (MacCrimmon and Gots 1972). Reproducing populations of rainbow trout occur entirely in the eastern and central basins.

Michigan

No runs were known to occur in Michigan waters (MacCrimmon and Gots 1972); however, commercial fishermen have identified the following spawning areas:

Woodtick Peninsula (41°44', 83°25'). From 1950 to 1970, adult steelhead were caught in the inlet west of Woodtick Peninsula (at 41°46', 83°27') near shore in less than about 9 ft of water; adult steelhead were also taken in Michigan waters around Turtle Island (41°45', 83°23') in 2-10 ft of water over hard bottom during May (Organ et al. 1978; Walter, pers. comm. 1981).

Ohio

O-1

Turtle Island (41°45', 83°23'). From 1950 to 1970, adult steelhead were caught around Turtle Island over hard bottom in 2-10 ft of water during May (Organ et al. 1978; Walter, pers. comm. 1981).

O-2

Rocky River (41°30', 81°50'). Spawning migrations occur September 15-April 15 (Cleveland Environ. Res. Group, undated; Teater 1976).

Chagrin River (41°41', 81°26'). Spring and fall runs occur (MacCrimmon and Gots 1972).

O-3

Conneaut River (41°58', 80°33'). Spring and fall runs occur (Aquat. Ecol. Assoc. 1977, 1978c; FWS 1979d; MacCrimmon and Gots 1972).

Turkey Creek (41°58', 80°32'). Ripe adults were collected in the creek during the spring and fall and were observed making redds in December and January. In 1977 and 1978, young-of-the-year (YOY) were collected in the creek, indicating that successful spawning occurred (Aquat. Ecol. Assoc. 1977, 1978c; USACE, undated b).

Pennsylvania

Raccoon Creek (41°59', 80°29'). Fall and spring runs occur (Aquat. Ecol. Assoc. 1978c), and natural reproduction occurs (USACE, undated b).

Crooked Creek (42°00', 80°26'). A limited spawning run occurs (Larsen, pers. comm. 1979), and natural reproduction is reported (USACE, undated b).

Elk Creek (42°01', 80°22'). This is a spawning area (Larsen, pers. comm. 1979; U.S. Army Eng. Dist. 1973; USDI 1967).

Trout Run (42°03', 80°16'). A limited spawning run occurs (Larsen, pers. comm. 1979).

Twenty Mile Creek (42°16', 79°47'). Anglers catch rainbow trout here during runs in the spring (Griswold and Galati, pers. comm. 1979; Larsen, pers. comm. 1979).

New York

Chautaugua Creek (42°20', 79°36'). The creek has a gravel and rock bottom and water depths of 2-4 ft. Ripe adults were caught in the fall and spring. Young-of-the-year are collected in the creek in the summer and fall (Griswold and Galati, pers. comm. 1979).

Canadaway Creek (42°28', 79°22'). Anglers catch gravid females in the creek in the spring; YOY were collected in October in 2-4 ft of water over gravel and rock (Griswold and Galati, pers. comm. 1979).

Scott Creek (42°30', 79°18'). Many gravid adults are collected here in the spring over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Unnamed tributary (42°31', 79°16'). Anglers catch gravid fish here in the spring; YOY are collected in the summer and fall, over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Walnut Creek (42°33', 79°10'). Anglers catch gravid adults here in the spring (Griswold and Galati, pers. comm. 1979; Larsen, pers. comm. 1979; USDI 1967).

Silver Creek (42°33', 79°10'). Fry and YOY were collected here in July-August in 2-4 ft of water over gravel and stone substrate (Griswold and Galati, pers. comm. 1979).

Cattaraugus Creek (42°34', 79°08'). Spawning occurs over gravel bottom at water depths to 6 ft. Gravid adults were collected here in September and October and YOY were observed in the creek in the summer (Griswold and Galati, pers. comm. 1979; MacCrimmon and Gots 1972; NYDEC 1977b; USDI 1967).

Delaware Creek (42°38', 79°04'). A limited run entering the creek and gravid adults have been collected. Spawning occurs over gravel in 1-3 ft of water (Buffalo Waterfront Devel. Comm., undated; Griswold and Galati, pers. comm. 1979).

Eighteenmile Creek (42°43', 78°58'). A fair to good run occurs; anglers catch gravid fish in the spring. Spawning takes place in the creek over gravel and stony bottom (Griswold and Galati, pers. comm. 1979).

Athol Springs (42°46', 78°53'). This is a planting site; concentrations of adults occur here in the spring and fall (NYDEC 1977b).

Ontario

OE-3

Kettle Creek (42°39', 81°13') (Environ. Can. 1977a).

Catfish Creek (42°39', 81°01') and Big Otter Creek (42°37', 80°48') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

OE-4

Clear Creek (42°34', 80°35') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Big Creek (42°36', 80°27'). A spawning run enters Big Creek in the spring and proceeds into Venison Creek and North Creek (Bidgood and Berst 1969; Environ. Can. 1977a; Kelso 1972; MacCrimmon and Gots 1972; OMNR 1973).

Forestville Creek (42°40', 80°22') and Gibsons Creek (42°39', 80°21') (OMNR 1973).

Cranes Creek (42°43', 80°19') and Dedrick Creek (42°36', 80°27') (Environ. Can. 1977a).

Potters (Normandale) Creek (42°43', 80°19') and Fishers Creek (42°43', 80°18'). A spawning run occurs in the spring (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Lawrence Creek (42°45', 80°16'). A spawning run enters the creek in the spring (OMNR 1973).

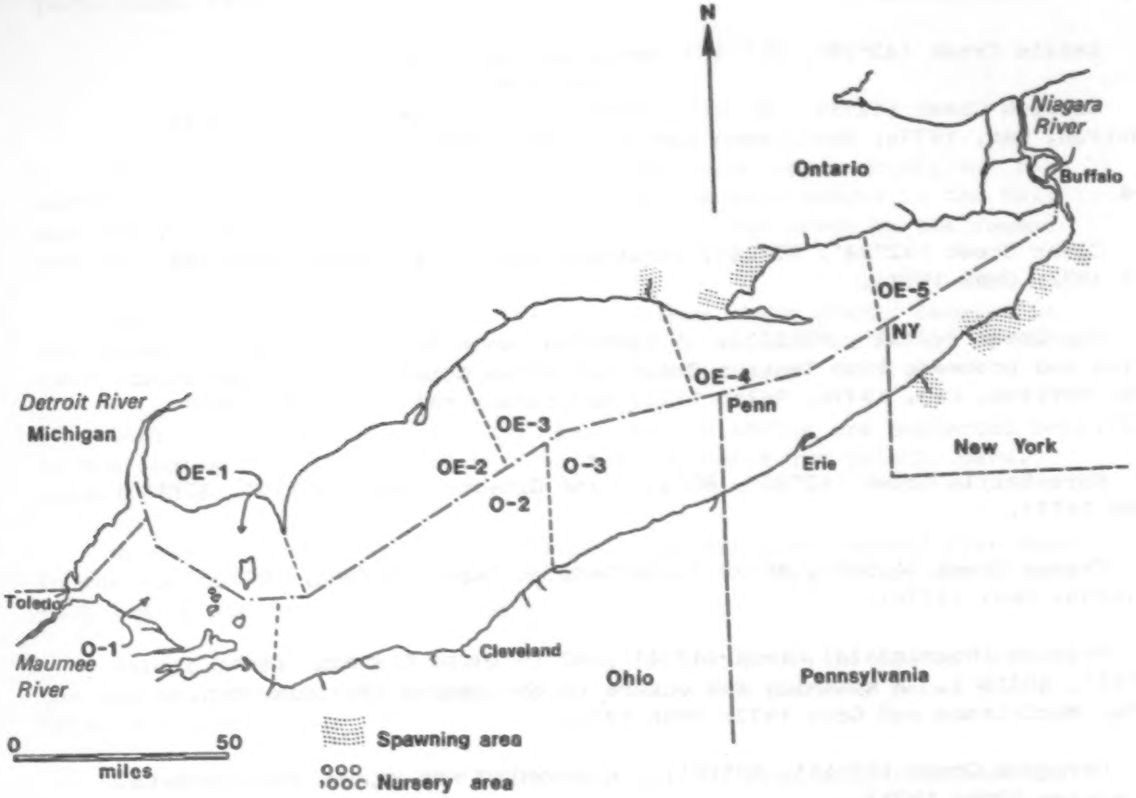
Young Creek (42°45', 80°15'). A spawning run enters the creek in the spring (Environ. Can. 1977a; Kelso 1972; MacCrimmon and Gots 1972; ONMR 1973).

Lynn River (42°47', 80°12'). A spawning run enters the river in the spring (Environ. Can. 1977a; OMNR 1973).

OE-5

Grand River (42°51', 79°35'). Spawning runs enter the river in the fall and spring (Environ. Can. 1977a; OMNR 1979). Fish have been reported to proceed 35-40 mi upstream (MacCrimmon and Gots 1972).

BROWN TROUT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Erie
New York
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Toledo
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Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Brown trout were introduced into the United States in about 1883 and subsequently entered the Great Lakes, probably from stream stockings (Moffett 1958; Scott and Crossman 1973). Plantings in Lake Erie and its tributaries have produced spawning runs in several tributaries.

Ohio

O-2

Chagrin River (41°41', 81°26'). Spawning may occur in the river (Trautman, pers. comm. 1979).

New York

Chautauqua Creek (42°20', 79°36'). This is one of the primary salmonid spawning tributaries in Lake Erie and supports natural reproduction of brown trout (NYDEC 1977b).

Canadaway Creek (42°28', 79°22'). Concentrations of adults occur in fall (NYDEC 1977b).

Dunkirk Harbor (42°30', 79°20'). Ripe fish have been collected here in October-March over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Scott Creek (42°30', 79°18'), Beaver Creek (42°31', 79°17'), Silver and Walnut Creeks (42°33', 79°10'), Cattaraugus Creek (42°34', 79°08'), Delaware Creek (42°38', 79°04'), and Big Sister Creek (42°40', 79°04'). Spawning runs occur in these streams (NYDEC 1977b).

Athol Springs (42°46', 78°53') (NYDEC 1977b).

Ontario

OE-3

Big Otter Creek (42°37', 80°48') (Environ. Can. 1977a; OMNR 1973).

OE-4

Big Creek (42°36', 80°27'), Potters Creek (42°43', 80°19'), Fishers Creek (42°43', 80°18'), Lawrence Creek (42°45', 80°16'), and Young Creek (42°45', 80°15'). Spawning runs occur in October and November (Environ. Can. 1977a; OMNR 1973).

LAKE TROUT

Native lake trout were abundant in the eastern basin, and very large catches were made annually in the late 1800s (Hartman 1972). Spawning occurred in October-December (Rathbun and Wakeham 1897) in shallow areas (Trautman 1957). Young-of-the-year were pelagic in open water (Greeley 1929). The population declined in the 1920s due to over-exploitation; few were taken after the mid-1930s, and the native stocks are extinct. Environmental degradation probably caused the extinction of the population that remained after the initial decline (Hartman 1972). Lake trout have been planted in Pennsylvania waters of Lake Erie since 1969 and in New York waters since 1975 (GLFC, in press).

New York

A substantial population of lake trout, which spawned about October 15-November 10, inhabited the eastern basin. The major reason for its decline was not pollution, but overfishing and wasteful spawn-taking operations (Moenig, undated).

Dunkirk Light (42°30', 79°21'). An historical spawning reef with rocky substrate extended west from Dunkirk Light between Dunkirk (42°29', 79°20') and Westfield (42°19', 79°35'). Fish from the deeper waters near the eastern end of the lake began to school in October, and spawning fish were taken near Dunkirk in November (Moore 1894; Rathbun and Wakeham 1897).

Ontario

OE-1

Point Pelee (41°55', 82°30') and Pelee Island (41°47', 82°40'). Rocky areas at the point and on the east side of the island may have provided limited spawning habitat (Moenig, undated).

OE-2

Rondeau (42°18', 81°55'). Rocky areas here may have provided limited spawning habitat (Moenig, undated).

OE-4

Long Point Bay (42°40', 80°10'). Lake trout spawned over rocky bottom in 18-24 ft of water between Port Ryerse (42°45', 80°15') and Port Dover (42°47', 80°12') (Moenig, undated). A commercial fisherman reported that a run entered Young Creek (42°45', 80°15') (Whillans, pers. comm. 1979).

COREGONUS spp.

Ohio

O-3

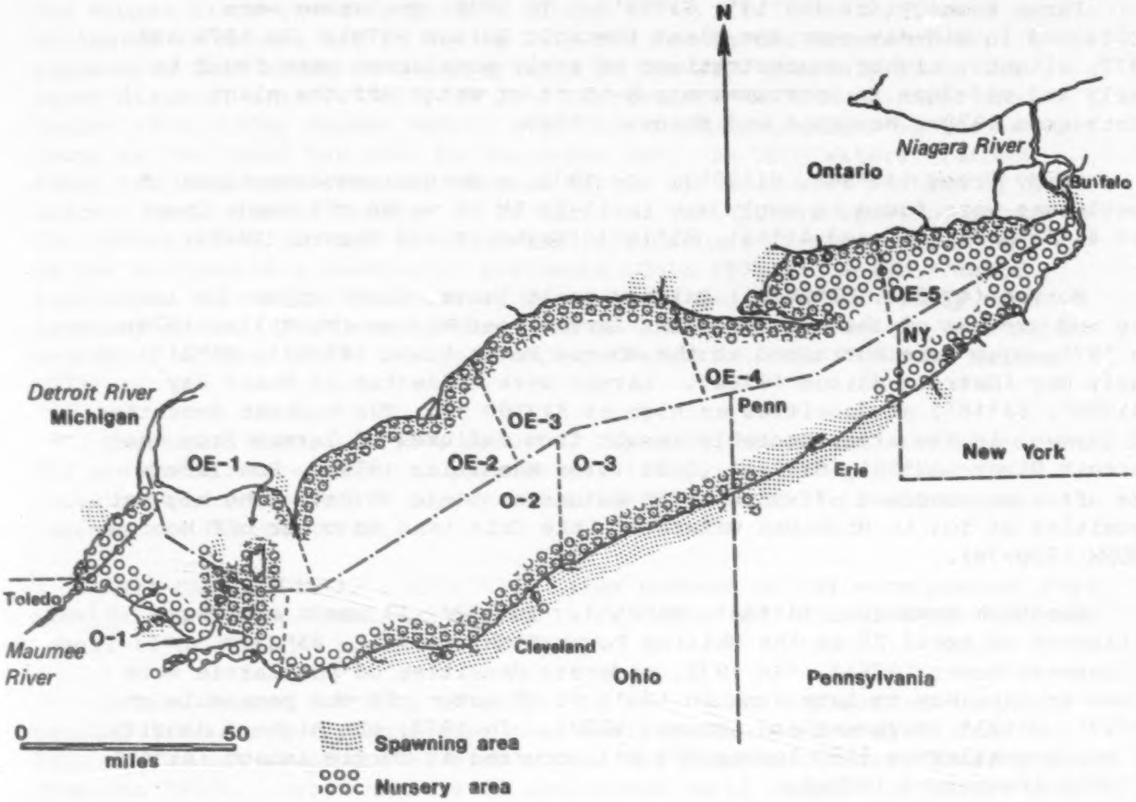
Perry Power Plant (41°48', 81°09'). In 1974, 1 coregonine larva, 0.6 in. long, was found nearshore in about 6-10 ft of water (NUS 1975).

SALMONID spp.

New York

Chautauqua Creek (42°20', 79°36'). This is one of the prime salmonid spawning streams entering Lake Erie (NYDEC 1977b).

RAINBOW SMELT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Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Rainbow smelt eggs planted in Crystal Lake (44°40', 86°10'), Michigan, in 1912 are believed to be the source of rainbow smelt found in all of the Great Lakes, except Lake Ontario. The first reported capture of smelt in Lake Erie occurred in 1935 at Port Dover (42°47', 80°12'), Ontario (Van Oosten 1937a). The first spawning run in Lake Erie occurred in 1940 in a drainage ditch west of Blenheim (42°18', 82°00'), Ontario (Roseborough 1962). Most of the successful spawning in Lake Erie occurs on sandy shoals along the Canadian shore (Applegate and Van Meter 1970; Scott 1967; Slastenenko 1958; USBCF 1966). Adults move inshore and into streams in late March and early April and move back to deeper waters just after spawning (FWS 1979d).

The western basin has few streams suitable for spawning, and, along the north shore, runs do not occur west of Point Pelee (41°55', 82°30') (Ferguson 1955; Regier 1963). Some rainbow smelt migrate into the western basin in the fall, spawn there in the spring, and then return to the central basin. Small concentrations of eggs have been recovered throughout the western basin on mud bottom; these eggs may have been spawned elsewhere on sandy bottom, which is the preferred spawning substrate in Lake Erie (Wolfert, pers. comm. 1979). Most hatching occurs May 1-15 at 50°F (Comm. Fish. Rev. 1961a).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1976, prolarvae were collected in mid-May near the plant (Detroit Edison 1978). In 1975 and 1977, slightly higher concentrations of early postlarvae were found in early and mid-June in approximately 6-18 ft of water off the plant (Patterson 1979a; Waybrant and Shauver 1979).

Sandy Creek (41°56', 83°20'). In 1975, moderate concentrations of postlarvae were found in early May in 12-24 ft of water off Sandy Creek (at 41°55', 83°18', and 41°54', 83°16') (Waybrant and Shauver 1979).

Monroe (41°55', 83°24'). Rainbow smelt larvae first appear in late May and are one of the most abundant larvae near Monroe (MacMillan 1976). In 1975, eggs were entrained at the Monroe Power Plant (41°53', 83°21') in early May (Detroit Edison 1976a). Larvae were collected in Brest Bay (41°55', 83°18') at densities as high as 31/100 m^3. The highest densities of larvae, in the area, probably result from influxes of larvae from the Detroit River (42°03', 83°08') (Cole 1976; MacMillan 1976). Postlarvae are often as abundant offshore as in estuaries (Cole 1978a). The highest densities of YOY in Michigan waters of Lake Erie tend to occur off Monroe (MDNR 1970-76).

Woodtick Peninsula (41°44', 83°25'). In 1974, 13 smelt eggs were collected on April 25 at the Whiting Power Plant (41°47', 83°27') (Consumers Power 1976a). In 1975, moderate densities of postlarvae were found in late May to late June in 12-18 ft of water off the peninsula at 41°47', 83°23' (Waybrant and Shauver 1979). In 1977, the highest density of early postlarvae (157 larvae/100 m^3) occurred at Turtle Island (41°45' 83°23') (Patterson 1979a).

Ohio

Rainbow smelt spawn in almost every creek and harbor along the Ohio shoreline from Lorain (41°28', 82°11') to Conneaut (41°58', 80°33') and also along shore over gravel and sand bars in water up to 10-12 ft deep (Trautman 1957, pers. comm. 1979; White, pers. comm. 1979). The stock is maintained primarily by shore spawning; recruitment from stream spawning is negligible (GLBC 1975). In the fall, young 1 to 1.5 in. long are generally found along the gravelly beaches, and outside the harbors, between Lorain and Conneaut (White, pers. comm. 1979). Large numbers of YOY were found all along the shoreline from Vermilion to Conneaut and along the south shore of the western basin (Anderson 1966; Baker 1966b, 1969c; Baker and Bower 1964, 1965; Baker and Scholl 1970, 1972; Manz 1963; Parker 1964; Rudolph and Scholl 1969; Seward 1967, 1968; Van Vooren and Davies 1974).

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Maumee Bay (41°43', 83°25'). Larvae were collected at the mouth of the Maumee River (41°41', 83°28') (CLEAR 1977). In 1975-77, larvae were collected in Maumee Bay in May to July but not in the Maumee River, suggesting that spawning occurred only in the bay, possibly along the diked disposal area (41°43', 83°27') (Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Snyder 1978). Much lower concentrations of larvae were found in the inner bay than in the outer bay. In Ohio waters, rainbow smelt fry were most abundant in late May in the southwest section of the western basin (Baker 1965). It is believed that little spawning occurs in the Maumee River, in any of the small tributaries, or along the shoreline in the southwestern portion of the basin (Cole 1978a). Rainbow smelt postlarvae are easily distributed by currents and disperse widely from spawning areas. The Detroit River (42°03', 83°08') appears to be a major source of rainbow smelt larvae entering the basin (Cole 1978a,b; Heniken 1977).

Toussaint River (41°35', 83°04'). Spawning runs enter the river, and YOY are found there (Rawson, pers. comm. 1979). In 1978, YOY were occasionally numerous off Locust Point (41°36', 83°05') in mid-August (Barnes and Reutter 1979).

East Harbor (41°32', 82°47'). Large numbers of YOY were present just outside the harbor (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1970; Rudolph and Scholl 1970).

Island Region (41°40', 82°45'). In the 1940s, collections of newly hatched larvae and fry indicated that smelt probably spawned in June and July on current-swept gravel bars around the islands (MacKay 1958a, 1969; Trautman 1957). Large numbers of adults and small numbers of larvae were found around the Bass Islands (41°41', 82°49') and Kelleys Island (41°36', 82°42'). Larvae found in the area could have been carried into the area from the Detroit River (42°03', 83°08') (Heniken 1977). By August, young, 2-3 in. long, were collected in the open lake at depths greater than 20 ft (Trautman 1957). In 1966 and 1967, YOY were most abundant at a station just south of Middle Sister Island (41°51', 83°00') in July and early August (Baker 1967a,c).

> South Bass Island (41°39', 82°50'). Spawning has been observed in seiche currents under the bridge between Terwilliger Pond (41°39', 82°50') and Squaw Harbor (41°39', 82°49') (Trautman, pers. comm. 1979).
>
> Kelleys Island Shoal (41°38', 82°39'). Rainbow smelt spawn here at water depths of less than 12 ft before the walleye spawns (Wolfert et al. 1975; Wolfert, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). Larvae were collected at the mouth of the Sandusky River (41°27', 82°59') (CLEAR 1977). Young-of-the-year are abundant in the area around Johnson Island (41°30', 82°44') (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1970; Rudolph and Scholl 1970).

O-2

Erie Nuclear Plant site (41°23', 82°30'). In 1977, rainbow smelt larvae were captured near the plant site in May and June. Spawning at the site occurred in late April or early May when the water temperature was about 44-50°F. Hatching began in early May and was completed by the end of May (Ohio Edison 1977). Young-of-the-year are most abundant in 45 ft or less of water in the area between Huron and Lorain (FWS 1979d). In 1962, YOY were found offshore between Huron and Lorain by early July (MacCallum and Regier 1970).

Beaver Creek (41°26', 82°15'). At sites to the 36 ft depth contour off the creek mouth, eggs have been collected in May, postlarvae in late May to September, and juveniles in July to September; YOY were collected in beach seines in late July (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). Lorain Harbor is a spawning area; adults are numerous in late April and larvae are abundant after late June (Geo-Marine 1978). In 1962, YOY were found offshore in this area by early July (MacCallum and Regier 1970).

Avon Lake Generating Station (41°30', 82°03'). Impingement of adults at the generating station indicate that large runs occurred in early May. A few prolarvae or fin-fold larvae were entrained in May but entrainment was greatest in June and mid-July, when postlarvae were most abundant (Applied Biology 1979c; Aquat. Ecol. Assoc. 1976c). In 1962, YOY were found offshore in this area by early July (MacCallum and Regier 1970).

Cleveland (41°31', 81°42'). In 1972-74 and 1976, YOY were abundant in Cleveland Harbor (41°31', 81°42') and in the Rocky River (41°30' 81°50') and adjacent shores; these sites may be spawning areas (Cleveland Environ. Res. Group, undated; White et al. 1975). At the Lakeshore Generating Station (41°32', 81°38'), most adults were impinged on May 9-10; many of these were believed to have died before they were impinged (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). In 1972-74, YOY smelt were collected in abundance in the Chagrin River and adjacent shores; these sites may be spawning areas (White et al. 1975). In 1975, prolarvae were collected at the East Lake Generating Station (41°40', 81°27') near the Chagrin River in May and June at water temperatures of 50-57°F. Spawning is believed to occur in the area or in the mouth of the Chagrin River, but only small numbers of larvae were collected here (Aquat. Ecol. Assoc. 1976b). In 1977-78, 8% of the larvae entrained at the plant were rainbow smelt. Most young rainbow smelt were entrained as postlarvae in August. Most adults were impinged in mid-May; many of these were believed to have died before they were impinged (Applied Biology 1979b).

O-3

Perry Nuclear Power Plant (41°48', 81°09'). Spawning begins in the area in late April and early May at water temperatures of 48-50°F. Eggs were collected in May, and young were present in May-late August (NUS 1975).

Arcola Creek (41°51', 81°00'). Rainbow smelt spawned here since 1949 (Langlois 1954; Trautman 1957); a run occurs in April (NUS 1975). Eggs were found at the mouth of the creek (Regier 1963).

Indian Creek (41°52', 80°55'). Spawning has occurred here since 1949 (Trautman 1957). Eggs were found at the barrier bar and in the gravel outwash at the mouth of the creek (Regier 1963).

Ashtabula (41°55', 80°47'). Rainbow smelt spawn near the Ashtabula power plants (41°55', 80°46') and in Ashtabula Harbor (41°55', 80°47'). More than 90% of fish impinged by the power plants in the spring were rainbow smelt. The largest run occurs in mid-May. Prolarvae were collected in late May. Rainbow smelt larvae are one of the few larvae collected regularly in the offshore waters at Ashtabula (Applied Biology 1979d,e; Aquat. Ecol. Assoc. 1976a; Hubbard 1977, as cited in Sweeney 1978; Sweeney 1978).

Conneaut (41°58', 80°33'). In 1977, larvae were collected in and at the mouths of the Conneaut River (41°58', 80°33') and Turkey Creek (41°58', 80°32'), in Conneaut Harbor (41°58', 80°33'), and offshore at sites between Conneaut and Raccoon Creek (41°59', 80°29') from June through August. The peak abundance of rainbow smelt larvae in the area occurred in late June and early July at water temperatures of about 66-79°F. Larvae were fairly abundant in offshore, nearshore, and harbor collections throughout July and August (Aquat. Ecol. Assoc. 1976a). Larvae were more abundant inside Conneaut Harbor than offshore (USACE, undated b).

Pennsylvania

Rainbow smelt spawn along the entire shoreline and in all the Pennsylvania tributaries of Lake Erie. The shoreline consists of a rock and gravel bottom with limited vegetation. Spawning occurs in 2-3 ft of water in the surge zone along the shoreline. Spawning in creeks usually occurs in the lower 100 yd during late April and early May in moderate current over rock, gravel, mud, or silt bottom, and usually filamentous algae (Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). Rainbow smelt eggs were found at the creek mouth (Regier 1963). Larvae were also found in the creek mouth and farther upstream in June and July (Aquat. Ecol. Assoc. 1976a; GPU Serv. Corp. 1979).

Crooked Creek (42°00', 80°26'), Trout Run (42°03', 80°16'), and Walnut Creek (42°04', 80°14'). Rainbow smelt eggs were found at the mouths of these creeks (Regier 1963).

Presque Isle (42°10', 80°06'). Spawning occurs on the sand bars along Presque Isle (Kenyon, pers. comm. 1979).

New York

In 1962, YOY were found throughout the eastern basin in September (MacCallum and Regier 1970).

Chautauqua Creek (42°20', 79°36'). Fishermen catch gravid fish in the creek, over gravel and rock bottom in 2-4 ft of water in the spring (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Eggs were collected in relatively high concentrations in April and May, mainly in nearshore waters, indicating that spawning occurs in the shallows of the bay or in Van Buren Creek (42°27', 79°24'). Rainbow smelt larvae were more abundant here than larvae of most other species. Prolarvae were collected in May to July. Rainbow smelt postlarvae were present until late August and constituted as much as 94% of the catch in late July. Rainbow smelt were 50% of YOY collected in the bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Canadaway Creek (42°28', 79°22'). Ripe adults were collected in the creek in the spring and spawning was observed over rock and gravel bottom (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 79°20'). Rainbow smelt eggs are present throughout the harbor (Niagara Mohawk Power Corp. 1976, as cited in Tex. Instrum. 1978; Tex. Instrum. 1976d). Ninety percent of the eggs entrained at the Dunkirk Steam Station (42°30', 79°21') during late April and May were rainbow smelt eggs (Tex. Instrum. 1977e). The presence of gravid, ripe, and spent fish in the harbor indicated that spawning occurred there (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). Rainbow smelt larvae were abundant; they were 70% of the total catch of larvae in near-surface waters. Prolarvae were present in May and June and postlarvae in May to July (Tex. Instrum. 1977d). Prolarvae were entrained from mid-May to late June and postlarvae from mid-May to September (Tex. Instrum. 1977e).

Scott Creek (42°30', 79°18'). Fishermen catch gravid rainbow smelt in the creek over gravel and rock bottom in the spring (Griswold and Galati, pers. comm. 1979).

Eagle Bay (42°32', 79°14'). Eggs were collected in high concentrations in April-May, mainly in nearshore waters, indicating that spawning occurs in the shallows of the bay or in Eagle Bay Creek (42°32', 79°14'). Rainbow smelt larvae were more abundant than larvae of most other species. Prolarvae were collected in May-July. Postlarvae were present until late August and were 90% of the postlarvae collected. Rainbow smelt made up 55% of YOY collected (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

The first smelt spawning run in Lake Erie occurred along the Canadian shore of the central basin in 1940 in a tributary west of Blenheim (42°18', 82°00') (Roseborough 1962). In the early 1940s, spawning occurred at Point Pelee (41°55', 82°30'). Egg collections have documented spawning along the entire northern shore of the central and eastern basins (Ferguson 1954; Regier 1963). Most spawning occurs on beaches and shoals in 10 ft or less of water. Few stream spawning populations remain, although runs also enter certain unpolluted and unobstructed tributaries (Applegate and Van Meter 1970; Ferguson 1954; USBCF 1966; USDI 1967). Rainbow smelt apparently prefer to spawn in smaller streams that have barrier bars or riffles near the mouth. They also spawn on gravel or bedrock along the north shore off Long Point (42°33', 80°10') and at Morgans Point (42°51', 79°21'), where there are strong currents (Regier 1963). Spawning runs usually occur in April or early May (Berst 1954; MacCallum and Regier 1970; Mahon, pers. comm. 1979; Nsembukya-Katuramu 1978; Regier 1963). Usually the spawning run begins at Point Pelee about the middle of April and lasts approximately 2 weeks; peak spawning occurs at 38-41°F. Subsequent runs follow the shore east of Point Pelee; spawning runs occur in the eastern basin about 2 weeks later than at Point Pelee (MacCallum and Regier 1970; Regier 1963). It has also been reported, however, that the spawning peaks occur throughout the lake at about the same time (late April) and that there is no progression from one end to the other (Berst 1954; Ferguson 1954, 1955).

Along the Canadian shore, YOY inhabit the inshore waters in the spring (MacCallum and Regier 1970). Fry are very abundant inshore at depths of 20 ft during mid-summer; they begin moving offshore in late summer (Ferguson 1965; Chen 1970). In 1962, YOY moved offshore from the spawning areas in the central and eastern basins and were collected by June in waters as deep as 50 ft (MacCallum and Regier 1970).

OE-1

Point Pelee (41°55', 82°30'). Spawning aggregations occur in 10 ft or less of water; spawning occurs on the current-swept beaches in April and early May (Regier 1962, 1963; Thomasson 1963). Point Pelee has large spawning runs in April, which usually last for 2 weeks (Ann Arbor News 1979b; Environ. Can. 1977a; MacCallum and Regier 1970; Regier 1962). The largest runs occurred during the late 1950s (Krause 1967). In 1959, spawning runs occurred at Point Pelee Park (41°58', 82°32') and the Leamington Dock (42°01', 82°36') in April (Roseborough 1962). Eggs were collected on the gravel bar that extends south off the tip of the point. Most eggs were deposited in water less than 10 ft deep in an area that extended at least 2,000 ft out from the tip of the point (Regier 1962). Until approximately 1944, major runs occurred in Sturgeon Creek (42°01', 82°34') (Ferguson 1954, 1955). Fry are abundant along the point during the summer (Ferguson 1955). In 1962, YOY were collected near Point Pelee;

some of these drifted south toward the Ohio shore. In late fall, YOY were collected throughout the eastern two thirds of the lake (MacCallum and Regier 1970).

OE-2

Wheatley (42°04', 82°26'). Spawning occurs on the beaches in late April (OMNR 1977b).

Kent County beaches (42°04', 82°27'--42°27', 81°40') and Mersea Township (42°01', 82°31') (Roseborough 1962).

Erieau (42°14', 81°55'). In 1961, runs occurred during the last week of April (Thomasson 1963).

Rondeau Park (42°17', 81°52') (Environ. Can. 1977a; Roseborough 1962). Many eggs were found here in the gravel (Regier 1963). Spawning peaks in late April (Ferguson 1955).

Point aux Pins (42°15', 81°52') (Environ. Can. 1977a). Many eggs were found in the gravel in current-swept areas, where spawning occurs (Regier 1963). In 1961, spawning occurred from mid-April to the second week of May (Thomasson 1963).

OE-3

Port Bruce (42°39', 81°01') and Port Stanley (42°39', 81°13') (Roseborough 1962).

Silver Creek (42°38', 80°53'). A run occurred in 1942 (Roseborough 1962).

Port Burwell Beach (42°37', 80°48') (Roseborough 1962).

South Otter Creek (42°37', 80°47'). A small run occurred in late April and early May (Nsembukya-Katuramu 1978).

OE-4

Clear Creek (42°34', 80°35'). A run occurs in early May (Nsembukya-Katuramu 1978).

Long Point Bay (42°40', 80°10'). Rainbow smelt spawn in water 5-12 ft deep (MacCallum and Regier 1970). Inner Bay (42°37', 80°22') is an important spawning area (Environ. Can. 1977a). Rainbow smelt have spawned or attempted to spawn in most of the streams entering Long Point Bay (Whillans, pers. comm. 1979); 60% of the larvae collected along the north shore of the bay are rainbow smelt (Hamley and MacLean 1979). Runs have been reported at the following sites:

Long Point (42°33', 80°10') (Roseborough 1962).

Pottohawk Point (42°37', 80°17'). Spawning occurs east of the point (Whillans 1977, pers. comm. 1979).

Turkey Point (42°39', 80°21'). Spawning occurs along the outer shores of the point (Roseborough 1962; Whillans 1977).

Normandale (Cranes) Creek (42°43', 80°19'). Runs have entered the creek since 1942 (Langlois 1954; Roseborough 1962); this is a prime spawning area (Mahon, pers. comm. 1979). Runs also occur on Normandale Beach (Roseborough 1962).

Fishers Creek (42°43', 80°18'). This is a prime spawning area (Mahon, pers. comm. 1979; Nsembukya-Katuramu 1978). Spawning also occurs at Fishers Glen Beach (Roseborough 1962).

Young Creek (42°45', 80°15'). This is a prime spawning area (Mahon, pers. comm. 1979). In 1959, spawning occurred at Port Ryerse (42°45', 80°15') (Roseborough 1962).

Port Dover (42°47', 80°12') (Roseborough 1962).

Nanticoke Generating Station (42°48', 80°03'). In 1974, 95% of YOY fish collected in entrainment samples at Nanticoke Generating Station in Long Point Bay were rainbow smelt. Young were most abundant from June 7-27, and were present in the collections through August 13 (Teleki 1976).

OE-5

Featherstone Point (42°49', 79°51') (Roseborough 1962).

Port Maitland (42°51', 79°35'). Spawning peaks in late April (Ferguson 1955).

Sandy Bay (42°56', 79°35'), Burnaby Bay (42°52', 79°22'), Sunset Bay (42°52', 79°20'), Ratheon Point (42°53', 79°19'), Port Colborne (42°53', 79°15'), and Niagara River (42°53', 78°55') (Roseborough 1962).

CENTRAL MUDMINNOW

In Lake Erie, spawning occurs in muddy, vegetated areas with sluggish water movement (Fish 1932).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). Spawning may still occur in the vegetated areas of some streams around Sandusky Bay (Trautman, pers. comm. 1979).

O-2

Rocky River (41°30', 81°50'). Spawning occurs in the muddy backwaters of marinas and yacht clubs on the west side of the river (White, pers. comm. 1979).

O-3

Geneva State Park (41°52', 80°57'). Gravid females were found in a swamp with thick mats of vegetation, primarily lizard's tail, on the bottom (MacLean, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10'). The central mudminnow breeds successfully in the vegetated, soft-bottomed lagoons during the spring when the water level is high (Mahon 1979, pers. comm. 1979). In 1977, one young-of-the-year was found in Long Point Crown Marsh (42°35', 80°25'), at the base of the point (Reid 1978).

GRASS PICKEREL

Ohio

O-2

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year (YOY) were found in the lower river; the river may be a spawning area (White et al. 1975).

O-3

Geneva State Park (41°52', 80°57'). In 1977, ripe adults were found in a swamp in the park in early April; this swamp had abundant growths of lizard's tail which formed mats 1 ft deep (MacLean, pers. comm. 1979).

Turkey Creek (41°58', 80°32'). Adults were present in the creek in April and May; a spawning run may enter the creek (USACE, undated b).

Pennsylvania

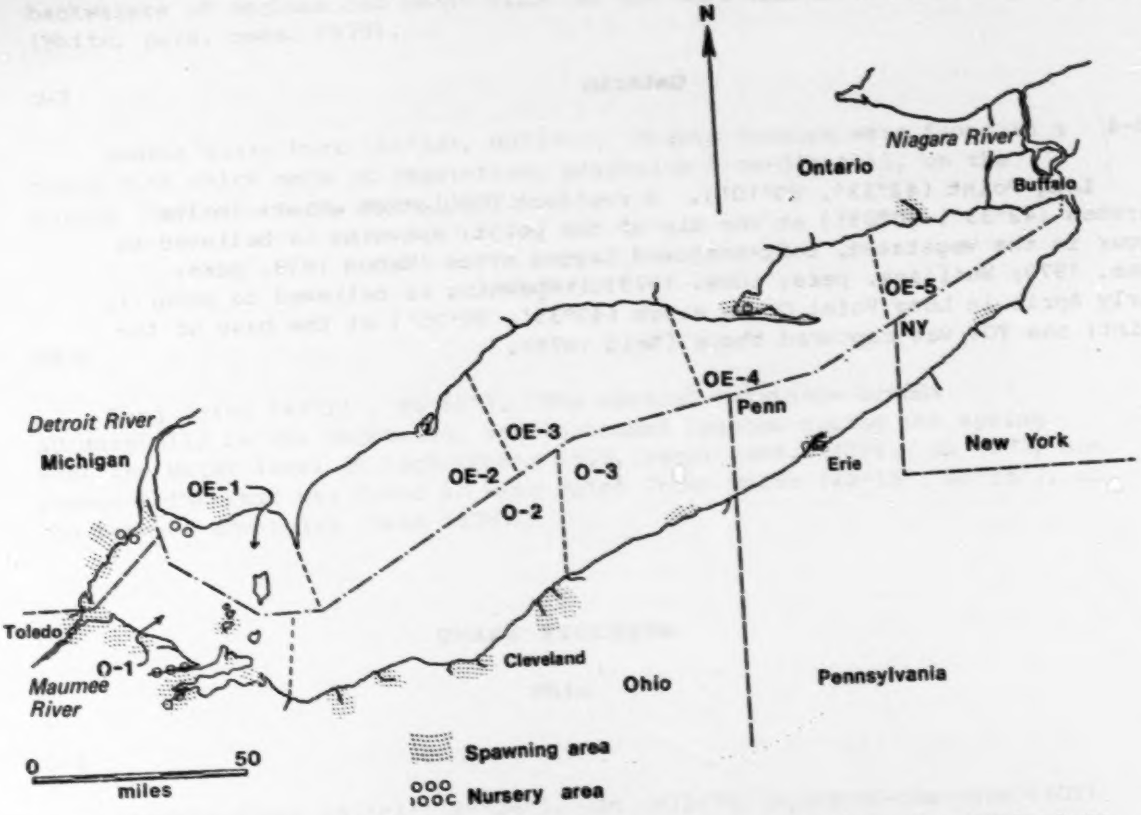
Presque Isle Bay (42°08', 80°07'). The lagoon area of Presque Isle Bay is a major spawning area; YOY were observed there in late May. The lagoon has a muck bottom, an average water depth of about 1 ft, negligible current, and clear water; emergent, submergent, and flooded terrestrial vegetation provide habitat seasonally (Kenyon, pers. comm. 1979). Pike Pond on the south side of the bay near the harbor entrance (exact location unknown) was known for the number and size of the grass pickerel that spawned there (Meehan 1895).

Ontario

OE-4

Long Point (42°33', 80°10'). A resident population exists in the marshes (42°33', 80°05') at the tip of the point; spawning is believed to occur in the vegetated, soft-bottomed lagoon areas (Mahon 1979, pers. comm. 1979; Whillans, pers. comm. 1979). Spawning is believed to occur in early April in Long Point Crown Marsh (42°35', 80°25') at the base of the point; one YOY was captured there (Reid 1978).

NORTHERN PIKE


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
New York
Erie
OE-2
O-3
OE-1
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Northern pike make extensive spawning migrations from Lake Erie into tributaries; some runs proceed to tributary headwaters. The runs begin in early spring, usually in March or early April, when the warm spring rains and ice break-up begin. Spawning occurs in sheltered, vegetated shallows, and flooded bottomlands (Greeley 1929; Langlois 1954; Trautman 1957, 1977; White et al. 1975; White, pers. comm. 1979). Northern pike historically ran into most of the rivers of the central basin (White, pers. comm. 1979). Now spawning is limited to any area where there is vegetation, such as in harbors or marinas (White, pers. comm. 1979). Most of what remains of Lake Erie's northern pike population is confined to the western basin (Wolfert, pers. comm. 1979). They spawn in shallow marshes and often run far upstream in tributaries to spawn over flooded bottomlands. The runs occur in early spring, mainly March and April, before the ice is completely out of the streams (Brown and Clark 1965; Clark 1950; Langlois 1954). Much of the spawning habitat was destroyed when the marshes along the south shore were diked to prevent an influx of carp (Wolfert, pers. comm. 1979).

By 1850, the population in Lake Erie was reduced, primarily because dams prevented migrations to spawning grounds. Other factors involved were ditching, draining, and diking of streams and marshes and the elimination of vegetation by turbidity and siltation (Trautman 1957, pers. comm. 1979).

Michigan

Huron River (42°02', 83°12')--Pointe Mouillee (42°01', 83°12'). Since 1911, northern pike have spawned along the shoreline over mud in 1-2 ft of water (Organ et al. 1978).

Swan Creek (41°58', 83°15'). Young were collected in July in channel cut-offs and small tributaries of lower Swan Creek (Langlois 1954). In 1975, larvae were collected in an area (41°59', 83°14') just north of Swan Creek in mid- to late June (Waybrant and Shauver, 1979).

Stony Creek (41°57', 83°18'). Since 1911, northern pike spawned over vegetation at the creek mouth (Organ et al. 1978).

Sandy Creek (41°56', 83°20'). Northern pike once spawned in the marshes of the estuary (Jaworski and Raphael 1978b).

Bolles Harbor (41°51', 83°24'). Northern pike suddenly appeared in fishermen's catches during the first week in February and began entering tributaries in early March, when the water temperature was 39°F (Langlois 1954). Spawning also occurs along the shoreline over gravel (Organ et al. 1978).

Woodtick Peninsula Bay (41°46', 83°27'). Spawning occurs on the inside of the peninsula over mud and gravel in 1-2 ft of water, from 41°47', 83°27' south to Indian Island (41°45', 83°27') (Organ et al. 1978).

Ohio

O-1

Maumee River (41°41', 83°28'). In the 1800s, northern pike ascended the river (Kirsch 1895), and spawning occurred in the Maumee Basin swamps. Spawning declined when spawning grounds were drained and blocked (Kettanek 1971; Pinsak and Meyer 1976). Limited spawning presently occurs in Maumee Bay (41°43', 83°25') from March 25 to April 20 (Pinsak and Meyer 1976).

Ward Canal (41°39', 83°14'). In 1948, a spawning run was observed in March at water temperatures of 31-52°F (Langlois 1954).

Turtle Creek (41°37', 83°08'). In 1948 and 1952, spawning runs were observed in March at water temperatures of 31-52°F (Kinney 1954; Langlois 1954).

Portage River (41°31', 82°56'). Young were collected in channel cutoffs and small tributaries of the lower river in July (Langlois 1954).

East Harbor (41°32', 82°47'). Spawning was observed and eggs were collected along the south and west shores of the harbor, which have cattail marshes and a substrate of fine silt and organic debris (Brown and Clark 1965; Clark 1950). In 1948, migrating fish were caught and spawning was observed in March in a ditch near the Ohio Highway #53 crossing (exact location unknown). Water temperature during the period ranged from 31-52°F (Langlois 1948).

South Bass Island (41°39', 82°50'). In 1950, spawning was observed in a small pond off Fishery Bay (41°39', 82°49') on April 15 at a water temperature of 60°F (Langlois 1954).

Sandusky Bay (41°29', 82°46'). Spawning runs enter small tributaries to the bay in March and April (Chapman 1954a, 1955). Presently spawning occurs in the marsh area in the southeast corner of the bay (41°26', 82°39'), between the two causeways leading to Cedar Point (41°29', 82°41') (FWS 1979d). Young have also been collected in cut-offs and small tributaries of the lower Sandusky River (41°27', 82°59') in July (Langlois 1954).

O-2

Old Woman Creek (41°23', 82°31'). The creek contains excellent spawning habitat (FWS 1979d).

Vermilion River (41°26', 82°22') and Black River (41°28', 82°11'). Historically, these rivers supported spawning runs (McCormick 1892).

Rocky River (41°30', 81°50'). A small number of northern pike enter the river to spawn (White, pers. comm. 1979).

Cuyahoga River (41°30', 81°43'). Historically, northern pike spawned in the river, but by 1850 the run had disappeared (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Northern pike enter the lower river to spawn (White, pers. comm. 1979).

Mentor Marsh (41°44', 81°19'). This is probably the major spawning area remaining in the central basin (White, pers. comm. 1979).

O-3

Ashtabula Harbor (41°55', 80°47'). Northern pike spawn behind a free-standing wall inside the harbor in a vegetated strip about 50 ft wide (White, pers. comm. 1979).

Turkey Creek (41°58', 80°32'). Adults were collected in the creek in April and May; this may have been a spawning run, but no evidence of spawning was found (USACE, undated b).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Both the open bay and the lagoon area are major spawning sites for a resident population of northern pike. Ripe adults were collected in the bay in late March and early April. Northern pike spawn somewhat earlier than the muskellunge (Buss and Larsen 1971; Buss and Miller 1967; Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979). In 1960, a spawning run started in the lagoon area on March 31 at a water temperature of 37°F and peaked at water temperatures of 40-46°F. Ten days later, a run started in the bay area at a water temperature of 40°F and peaked at water temperatures of 40-50°F. Possibly two separate populations were involved (Buss and Larsen 1961). Northern pike spawn in shallower lagoons than do muskellunge (Buss and Miller 1967). Young-of-the-year were collected during late May and early June. The lagoon area is very shallow, has a muck bottom, negligible current, abundant submergent and emergent aquatic vegetation, and flooded terrestrial vegetation. The lagoon is considered to be a major spawning and nursery area (Kenyon, pers. comm. 1979).

New York

Dunkirk Harbor (42°30', 79°20'). This is a probable spawning area (NYDEC 1977b).

Ontario

OE-1

Colchester (41°59', 82°56'). In 1975, larvae were present in low numbers in late June and early July in 24-30 ft of water at 41°59', 82°59', about 3 mi W of Colchester (Waybrant and Shauver 1979).

Cedar Creek (42°01', 82°47') and Wolf Creek (location unknown). In 1946, spawning was observed in small tributaries on March 15 (Langlois 1954).

OE-2

Rondeau Harbour (42°15', 81°53'). "The Ponds," a marsh area along the southeast shore, is a spawning ground and a nursery area. Hundreds of fingerlings have been found here in June (Berst 1950).

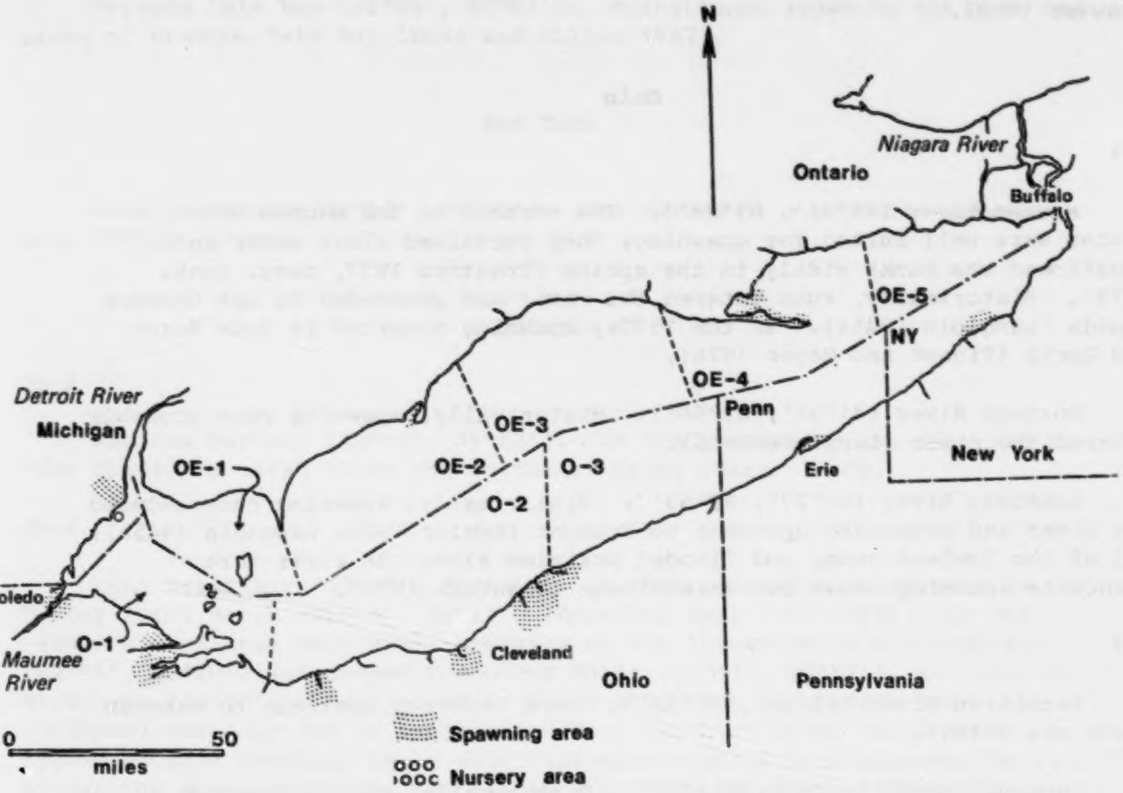
OE-4

Long Point Bay (42°40', 80°10'). Spawning is believed to occur here in late March and early April (Reid 1978). The area is presently a migration route to the tributary rivers, and a large spawning migration occurs in the spring just after ice break-up or even under the ice. In 1894, the influx into Inner Bay (42°37', 80°22') was on the order of millions of fish, and in 1900, it was declared the finest spawning run on Lake Erie. Northern pike also spawned in Long Point Marsh (42°35', 80°17') and Turkey Point Marsh (42°39', 80°21'), as well as in the bay itself (Whillans 1977). By 1930, the main spawning grounds had shifted from Big Creek Marsh to the east along the south shore (Whillans 1979a). In recent years, spawning was observed in Big Creek (42°36', 80°27') and Big Creek Marsh (42°36', 80°27') (Whillans 1977). Spawning occurs in almost all of the shallow marshy areas of Inner and Long Point Bays and in the lagoon areas of Long Point (42°33', 80°10') (Hamley and MacLean 1979; Mahon 1979, pers. comm. 1979; Whillans, pers. comm. 1979). A few young-of-the-year were found in Long Point Crown Marsh (42°35', 80°25') at the base of the point (Reid 1978).

OE-5

Grand River (42°51', 79°35'). Large runs of northern pike entered the river (Kerr and Kerr 1860-1898).

MUSKELLUNGE


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
OE-2
O-3
Erie
New York
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
▨ Spawning area
ooo Nursery area
0
50
miles

Muskellunge make extensive spawning migrations from Lake Erie into tributaries in early spring shortly before or after ice breakup; sometimes runs proceed to tributary headwaters. Spawning occurs in vegetated shallows, either among submerged aquatic or flooded terrestrial vegetation (Fish 1932; Langlois 1954; Trautman 1957, 1977, pers. comm. 1979; USDI 1967; White et al. 1975).

The demise of the muskellunge populations in Lake Erie by about 1850 was caused by blockage of tributary streams by dams, draining of marshes, ditching of streams, isolation of marshes by dikes, and elimination of aquatic vegetation by turbidity and siltation (Trautman 1957; USDI 1967). Historically, muskellunge migrated into the rivers of the western basin; this spawning habitat is now totally destroyed. Limited spawning may be occurring along the Michigan shore (Waybrant and Shauver, 1979).

Michigan

Huron River (42°02', 83°12'). Historically, spawning runs entered the river and proceeded upstream to Ann Arbor (Langlois 1945a).

Swan Creek (41°58', 83°15'). In 1976, a few larvae tentatively identified as muskellunge were captured in late April in 0-6 ft of water just north of the mouth of Swan Creek at 41°59', 83°14' (Waybrant and Shauver 1979).

Ohio

O-1

Maumee River (41°41', 83°28'). The streams of the Maumee River system were well suited for spawning; they contained clear water and overflowed the banks widely in the spring (Trautman 1957, pers. comm. 1979). Historically, runs entered the river and proceeded to Les Grandes Rapids (Langlois 1945a). In the 1970s, spawning occurred in late March and April (Pinsak and Meyer 1976).

Portage River (41°31', 82°56'). Historically, spawning runs probably entered the river (Langlois 1965).

Sandusky River (41°27', 82°59'). Historically, spawning runs entered the river and proceeded upstream to Fremont (Keeler 1904; Langlois 1945a); all of the lowland swamp and flooded prairies along the river were favorable spawning areas for muskellunge (Trautman 1975).

O-2

Vermilion River (41°26', 82°22'). Runs occurred upstream to Wakeman (Langlois 1945a).

Cuyahoga River (41°30', 81°43'). Historically, runs proceeded upstream to the rapids at Akron (Langlois 1945a; Trautman 1957; White, pers. comm. 1979) until the river was destroyed by pollution (USDI 1967). Muskellunge spawned throughout the marshes that surrounded Cleveland and began to disappear about 1850 (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Very limited runs enter the lower river (White, pers. comm. 1979).

Mentor Marsh (41°44', 81°19'). A moderate run occurs (White, pers. comm. 1979).

O-3

Grand River (41°46', 81°17'). Historically, spawning runs entered the river (Langlois 1945a). The resident population in the upper Grand River is believed to be a remnant of the run that existed before a dam was built near the river mouth (GLBC 1975). Moderate runs still enter the river (White, pers. comm. 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Muskellunge spawn in the open bay areas of Presque Isle Bay (Buss and Miller 1967).

New York

Dunkirk Harbor (42°30', 79°20'). The harbor is a probable spawning area (NYDEC 1977b).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). In 1950, spawning was observed in "The Ponds," a marsh along the southeast shore (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). In 1888, muskellunge spawned in Turkey Point Marsh (42°39', 80°21') (Kerr and Kerr 1860-1898). In the 1920s, muskellunge were still spawning by the thousands in Big Rice Bay (42°36', 80°20') and around Pottohawk Point (42°37', 80°17'), and east to Bluff Bar (42°35', 80°09'), but by about 1930, the population suddenly collapsed possibly due to competition from northern pike, which were prevented from reaching their usual spawning grounds by a causeway built across the west end of the bay (42°36', 80°27') (Whillans 1977, 1979a,b).

STONEROLLER

Pennsylvania

Trout Run (42°03', 80°16'). Stonerollers spawn at the mouth of the creek, in about 1 ft of water, in moderately swift current, over gravel and rock substrate with no vegetation. One male in breeding color was collected in April (Kenyon, pers. comm. 1979).

GOLDFISH

Goldfish are native to eastern Asia. It is not definitely known when they were introduced into U.S. waters, but by 1889 a goldfish farm was operating in Maryland (Scott and Crossman 1973). The introduction of goldfish into Lake Erie is not recorded. Goldfish in Lake Erie spawn in sheltered bays, creek mouths, and shoreline areas over mud and vegetation (Greeley 1929; Langlois 1954).

Michigan

Pointe Mouillee (42°01', 83°12'). Spawning occurs in the marshes over mud and vegetation (Organ et al. 1978).

Monroe (41°55', 83°24'). In 1973-74, spawning was observed in the discharge canal of the Monroe Power Plant (41°53', 83°21'); densities of larvae were greater here than in the lake (Cole 1976). Some young-of-the-year (YOY) were also found in the discharge canal (Parkhurst 1971).

Woodchuck Creek (41°51', 83°24')--Whitewood Creek (41°48', 83°26'). Since 1950, goldfish have spawned along this shoreline over mud at water depths of 12 ft or less (Organ et al. 1978).

Indian Island (41°45', 83°27'). Since 1950, goldfish have spawned around the island in water 2 ft deep (Organ et al. 1978).

Ohio

O-1

Goldfish spawn in marshes along the entire south shore of the western basin. Young-of-the-year then move from the marshes to shoreline areas, where they remain for much of their first year (Wolfert, pers. comm. 1979).

Maumee Bay (41°43', 83°25'). Goldfish spawn in nearshore areas from 41°44', 83°27' south to the Maumee River (41°41', 83°28') and east to Cedar Point (41°42', 83°20') from late May to August (Pinsak and Meyer 1976).

Locust Point (41°36', 83°05'). Goldfish spawn in the Davis-Besse Power Station intake canal (41°36', 83°04') (Reutter 1979a).

South Bass Island (41'39', 82°50'). Eggs were collected in Squaw Harbor (41°39', 82°49') as late as August 17 (Battle 1940), and fry were found in Terwilliger Pond (41°39', 82°50') over mud bottom among vegetation (Turner 1920a).

Sandusky Bay (41°29', 82°46'). Since 1953, goldfish have spawned on the vegetation in the bay (Chapman 1955; FWS 1979d; Hartley 1975; Keller 1964a). In 1974, YOY were present in the bay in June (Hartley and Herdendorf 1975).

O-2

Black River (41°28', 82°11'). In 1975, goldfish eggs were numerous in late June outside the west breakwall of the harbor (Wapora 1977a).

Cleveland (41°30', 81°43'). Goldfish spawn in Cleveland Harbor (41°31', 81°42'); eggs are deposited on the undersides of boats in marinas and on pilings (White, pers. comm. 1979; White et al. 1975). In 1972-74, fry and YOY were common in the harbor; YOY were also collected from the lower portions of the Rocky River (41°30', 81°50') (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, YOY were collected from the mouth of the river and along the adjacent lake shore (White et al. 1975). Goldfish enter the river to spawn for an extended period in mid-April to late July; greatest larvae production occurs in late June. Larvae are found in backwater areas upstream, in the lower river, and on beaches at the mouth (Environ. Resour. Assoc. 1978). Spawning also occurs in the warm water discharge of the Eastlake Generating Station (41°40', 81°27'), a few hundred yards west of the mouth of the Chagrin River in late March (White, pers. comm. 1979).

Pennsylvania

Elk Creek (42°01', 80°22'). Ripe adults were collected in May at the mouth of the creek (GPU Serv. Corp. 1979).

New York

Van Buren Bay (42°27', 79°25'). In 1975, a few prolarvae and postlarvae were found from mid-May to August in the lake near Van Buren Bay (Envirosphere 1977a; Tex. Instrum. 1977a).

Dunkirk Harbor (42°30', 79°20'). Young goldfish were very abundant in Dunkirk Harbor during late summer (Greeley 1929). In 1975, spawning was observed in late June (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978).

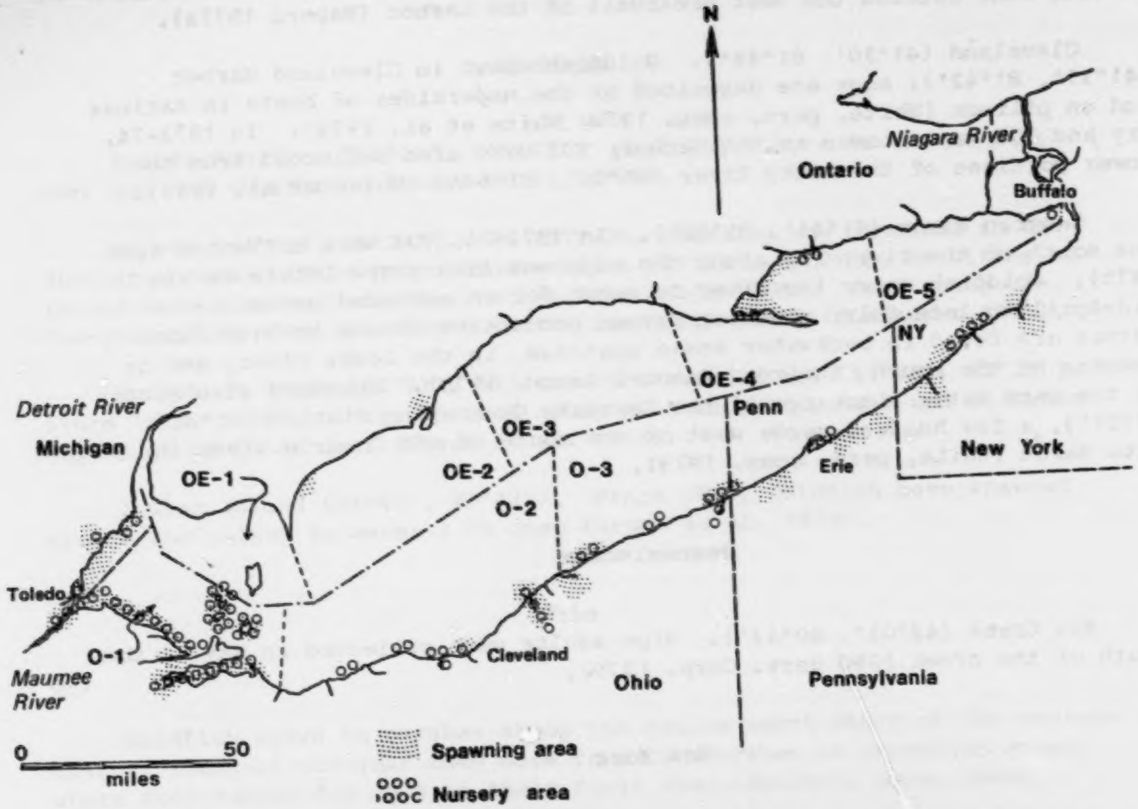
Eagle Bay (42°32', 79°14'). In 1975, eggs were collected in the lake near Eagle Bay in early June. Prolarvae and postlarvae of goldfish were found in mid-May to July (Envirosphere 1977a; Tex. Instrum. 1977a).

Ontario

OE-4

Long Point (42°33', 80°10'). Goldfish enter the lagoons at the tip of the point to spawn. Very few young are found in the lagoons; the young evidently migrate to the lake (Mahon 1979; Mahon and Balon 1977b).

CARP


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
OE-2
O-3
Erie
New York
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

The initial plantings of carp were made in the inland waters of the U.S. as early as 1831 (McCrimmon 1968). The first recorded capture of carp in Lake Erie occurred near the mouth of the Raisin River (41°53', 83°20'), Michigan, in 1883. Carp were abundant in Lake Erie in the 1880s, and a major commercial carp fishery was established in U.S. waters by 1886 (Cole 1905; Smiley 1886). The origin of these fish is unknown. Plantings were made in the Sandusky River (41°27', 82°59') in 1879, in the Maumee River (41°41', 83°28'), Ten-mile Creek (41°41', 83°32'), and near Kelleys Island (41°36', 82°42') in 1881 (Smiley 1886), in inland waters of Michigan in the 1880s, and in the waters of Erie County, Pennsylvania, in 1880 (McCrimmon 1968).

The peak of the spawning season in Lake Erie occurs in late May and early June (Cole 1905; Langlois 1954), but spawning may extend into August (Fish 1932). In the western basin, spawning occurs in marshy, vegetated areas along the west and south shores (Cole 1905; Parkhurst 1971; Trautman 1957, pers. comm. 1979; Wolfert, pers. comm. 1979). The young move out of the marshes but stay along shore for most of their first year (Wolfert, pers. comm. 1979). Very few larvae are found in open lake waters (Nelson 1975; Nelson and Cole 1975). In the central basin, carp also spawn in the vegetated, shallow protected areas, such as harbors and river mouths (White, pers. comm. 1979). In the eastern basin, carp spawn primarily in bays, harbors, and protected waters.

Michigan

Huron River (42°02', 83°12')--Pointe Mouillee (42°01', 83°12'). The vegetated backwater areas here support most of the carp production in Michigan waters (Waybrant and Shauver 1979). Since 1920, spawning has occurred throughout the marsh (Organ et al. 1978). In 1975, larvae were most abundant in an area (42°00', 83°11') off Pointe Mouillee in late June and early July in 6-12 ft of water (Waybrant and Shauver 1979).

Swan Creek (41°58', 83°15'). Carp spawn off the creek mouth over mud and to the 18 ft depth contour south to Stony Point (41°56', 83°16') over rock (Organ et al. 1978). In 1976, eggs, prolarvae, and early postlarvae were collected in the area near the Fermi Power Plant (41°57', 83°15') in May to August (Detroit Edison 1976g).

Brest Bay (41°55', 83°18'). Carp spawn over mud and vegetation throughout the bay (Organ et al. 1978).

Raisin River (41°53', 83°20'). In the early 1900s, the extensive marshes at Monroe (41°55', 83°24') were probable spawning habitat (Cole 1905). Yolk-sac larvae are abundant in the upper reaches of the river (Nelson 1975; Nelson and Cole 1975). Spawning carp are commonly seen, and prolarvae are abundant in the discharge canal of the Monroe Power Plant (41°53', 83°21'). In the heated water of the discharge canal, spawning temperatures are reached as early as late March; in the adjacent unheated waters of the Raisin River spawning temperatures are not reached until late May (Cole 1976, 1978a,b; Nelson 1975; Nelson and Cole 1975). Since 1952, spawning has occurred over mud along the shoreline at the river mouth; since 1911, spawning has occurred over vegetation in the river backwaters (Organ et al. 1978).

La Plaisance Bay (41°52', 83°22')--Whitewood Creek (41°48', 83°26'). Since 1950, spawning has occurred here over mud and gravel (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Since the 1950s, carp have spawned over mud bottom on the lake side of the peninsula (at 41°46', 83°26') and also on the west side off Bay Creek (41°47', 83°27') and around Indian Island (41°45', 83°27') (Organ et al. 1978). Spawning has been observed in shallow water along the cattail-lined shores of Hooper Run (41°45', 83°28') (U.S. Army Eng. Dist., Detroit, 1976). In 1964, considerable spawning occurred in the diked marshes of southeast Monroe County from April to June (King and Hunt 1967). In 1978, carp larvae were entrained at the Whiting Power Plant (41°47', 83°27') and others were collected from the bay; peak catch in the bay occurred in June (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Carp spawn in the marshy areas of the bay (Trautman, pers. comm. 1979). Spawning is believed to occur nearshore and north of the Maumee River between 41°44', 83°27' and 41°42', 83°28' and from the mouth of the Maumee River (41°41', 83°28') to Cedar Point (41°42', 83°20') during June 1 to August 10 (Pinsak and Meyer 1976). In 1933, eggs were collected here from vegetation (Wright and Tidd 1933). In 1975-77, YOY were collected in the bay (Herdendorf 1977; Herdendorf and Cooper 1975, 1976). In 1975, ripe or gravid carp were collected in the bay during May and June, and a few YOY were subsequently collected in late July (USACE 1976c). Fairly high densities of early and late postlarvae were found at a location (41°44', 82°21') north of Cedar Point and around Turtle Island (41°45', 83°23') (Patterson 1979a). Carp larvae are more abundant on riffles in the Maumee River (41°41', 83°28') than in limnetic estuarine reaches (CLEAR 1977, 1978). In 1980, eggs were collected among Cladophora, attached to rock and/or in floating mats, on the Perrysburg riffles on May 16 at a water temperature of 66°F. Larvae that hatched from these eggs were identified as carp (Goodyear, pers. comm. 1980).

Ward Canal (41°39', 83°14'). In 1977, early and late postlarvae were most abundant in this area in early June (Patterson 1979a).

Metzger Marsh (41°39', 83°14'). In 1975, larvae were found here in early May (Herdendorf et al. 1976).

Portage River (41°31', 82°56'). The extensive marshes above Port Clinton were probable spawning habitat (Cole 1905).

Island Region (41°40', 82°45'). Carp eggs were collected in rocky reef areas around the Bass Islands (41°41', 82°49'), and larvae are concentrated in rocky areas among Cladophora around the Bass Islands and Kelleys Island (41°36', 82°42') (CLEAR 1978; Heniken 1977).

South Bass Island (41°39', 82°50'). Carp spawn in Fishery Bay (41°39', 82°49'). In 1949, eggs were collected from Cladophora fronds on bouldery shoals in early June (Langlois 1954). Fry were collected along the shoreline of the island at Terwilliger Pond (41°39', 82°50') and the Perry Monument (41°39', 82°49') in marshy areas over a mud bottom at water depths of 1-7 ft and in the bay on the east shore (at 41°39', 82°48') along the shallow, sandy beach among Eleochirus and submergent vegetation (Turner 1920a).

Middle Bass Island (41°41', 82°49'). Fry were collected on the north shore (at 41°42', 82°48') in shallow water. The substrate was gravel and boulders; submergent vegetation was present to water depths of 4 ft (Turner 1920a).

North Bass Island (41°43', 82°49'). Fry were collected on the south shore at 41°42', 82°49' along a sand beach with a steep slope and no vegetation (Turner 1920a).

Sandusky Bay (41°29', 82°46'). This is a major spawning area; carp spawn here in late spring and early summer among vegetation in the shallow shore and marsh areas (Chapman 1954b, 1955; Cole 1905; Edmister 1940; FWS 1979d; Trautman, pers. comm. 1979). Young-of-the-year (YOY) have been collected since the early 1950s in most areas of the bay, but they are especially common in protected areas among aquatic vegetation (Chapman 1955; Keller 1964a). Carp also enter the marshes along the Sandusky River (41°27', 82°59') to spawn in water less than 2 ft deep (Cole 1905). Larvae are more abundant in riffle areas of the river than in the limnetic estuarine areas (CLEAR 1977).

O-2

Beaver Creek (41°26', 82°15'). Prolarvae were collected in several areas off the creek during June 12-August 2; abundance of prolarvae peaked on July 5. Early postlarvae were present out to the 36 ft depth contour on June 12 and July 15 (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). Larvae were abundant in Lorain Harbor; this may be a spawning area (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, larvae were collected in the vicinity of the Avon Lake Power Plant in June (Aquat. Ecol. Assoc. 1976c). In 1977-78, larvae were entrained at the plant from April 13 through June and peak entrainment occurred during late May and June. About 22% of the larvae entrained annually at the plant were carp. Almost half of the larvae collected in the lake near the plant in the spring were carp (Applied Biology 1979c).

Cleveland (41°30', 81°43'). Carp spawn in Cleveland Harbor (41°31', 81°42') (White, pers. comm. 1979). In 1972-74, YOY were common in the harbor and also were collected in the Rocky River (41°30', 81°50'), which may be a spawning area (White et al. 1975). In 1977-78, carp was the most abundant larva entrained at the Lakeshore Power Plant (41°32', 81°38') in June and July (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). Carp enter the river to spawn in mid-April to late July; the greatest production of larvae occurs in late June. Young-of-the-year are collected in upstream backwaters, in the lower river, and on beaches at the mouth (Environ. Resour. Assoc. 1978; White et al. 1975; White, pers. comm. 1979). In 1975, a few prolarvae were collected at the East Lake Power Plant (41°40', 81°27') near the river in July; spawning was believed to occur near the river mouth (Aquat. Ecol. Assoc. 1976b). In 1977-78, carp was the second most abundant larva entrained at the plant from late May through August (Applied Biology 1979b).

O-3

Grand River (41°46', 81°17'). Carp enter the river to spawn (White, pers. comm. 1979).

Perry Power Plant (41°48', 81°09'). Larvae were collected in early June and July; prolarvae were most abundant on July 12 at a water temperature of 68°F (NUS 1975).

Ashtabula (41°55', 80°47'). In 1977-78, larvae were collected at the Ashtabula power plants in May to August; abundance of larvae peaked on August 8 (Applied Biology 1979d,e). Carp larvae were almost half of the larvae entrained throughout the summer (Applied Biology 1979e).

Conneaut (41°58', 80°33'). In 1977, eggs and larvae were collected at both nearshore and offshore sites between Conneaut and Raccoon Creek (41°59', 80°29') in late June and early July. Larvae were also collected in Conneaut Harbor (41°58', 80°33') and the Conneaut River (41°58', 80°33') during June and July. Larval abundance peaked in offshore waters on July 5, and in nearshore waters during the week of July 12. Larvae were also collected at the mouth of Turkey Creek (41°58', 80°32') in July (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Elk Creek (42°01', 80°22'). Carp enter the creek and spawn in late May and early June in an area 1-6 ft deep with light but variable current; the substrate is mud, and filamentous algae and submergent vegetation are present (Kenyon, pers. comm. 1979). Ripe adults were collected in May at the creek mouth; larvae were also collected there (GPU Serv. Corp. 1979).

Walnut Creek (42°04', 80°14'). Carp enter the creek and spawn from late May to early June near the mouth; the substrate is bedrock with some mud, submergent vegetation, and filamentous algae (Kenyon, pers. comm. 1979).

Presque Isle Bay (42°08', 80°07'). The bay, including the lagoons of Presque Isle (42°10', 80°06'), is a major spawning area. Ripe adults were collected in the bay in mid- to late May. Spawning occurs over mud bottom at depths of 2-3 ft in the lagoons and at depths to 12 ft in the bay, where water currents are minimal and aquatic vegetation is abundant. Young-of-the-year were also collected in the bay (Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979). In the early 1900s, the marshes at Erie (42°07', 80°05') were reported to be probable breeding habitat (Cole 1905).

Outer Bay (42°09', 80°04'). Spawning adults were collected in late May and early June immediately outside the mouth of Presque Isle Bay. The area is 1-6 ft deep with a mud-muck bottom, variable currents, and little vegetation (Kenyon, pers. comm. 1979).

Fourmile Creek (42°09', 80°02'), Sixmile Creek (42°11', 79°59'), and Sixteenmile Creek (42°14', 79°50'). Spawning was observed in late May and early June in these creeks, within 100 yd of the lake. The substrate is bedrock and mud; some filamentous algae and submergent aquatic plants are present (Kenyon, pers. comm. 1979).

New York

Chautauqua Creek (42°20', 79°36'). Ripe adults enter the creek in June, and spawning has been cbserved in 2-4 ft of water over gravel and rock (Griswold and Galati, pers. comm. 1979).

Barcelona Harbor (42°20', 79°36'). Ripe adults were observed in the harbor in late May (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Prolarvae and postlarvae were collected in mid-May through July, suggesting spawning may occur in the area (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). Ripe adults were present in late May. Spawning was observed on rock and gravel in 2-4 ft of water (Grisold and Galati, pers. comm. 1979). In 1928, gravid adults were found in the harbor in late June (Greeley 1929). Recently, spawning was observed in the harbor in late June (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978) and eggs were found throughout the harbor (Niagara Mohawk Power 1976, as cited in Tex. Instrum. 1978). Eggs of carp were present during June and July 1976 and were most abundant on June 14. Prolarvae were very abundant during June through August and were most abundant in mid-June, near the bottom. Postlarvae were collected in June through August (Tex. Instrum. 1977d).

Eagle Bay (42°32', 79°14'). In 1975, prolarvae and postlarvae were very abundant and were collected in mid-May through July; yolk sac prolarvae dominated surface collections (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undated a). In 1976, eggs were collected in high densities near bottom at the 10 ft depth contour in mid-June. Prolarvae were abundant in mid-June to early August; abundance peaked on June 18, when most of the larvae collected were carp. Postlarvae were present in July (Tex. Instrum. 1977a).

Cattaraugus Creek (42°34', 79°08'). Carp were collected here as they migrated to inshore areas and creek mouths to spawn (Greeley 1929).

Ontario

OE-1

In the early 1900s, the northern shore of the western basin had extensive marshes suitable for carp spawning (Cole 1905).

OE-2

Wheatley (42°04', 82°26'). In 1979, considerable spawning activity of carp was seen in a small pond immediately off the beach in late June and early July (Down, pers. comm. 1979).

Rondeau Harbour (42°15', 81°53'). In 1950, spawning was observed in late May in the creeks that empty into the northwest portion of the bay (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). Since 1896, carp have spawned in shallow water throughout the bay and surrounding marshes (Whillans 1977). Spawning was observed throughout the area in the shallow, vegetated soft-bottomed lagoon areas (Mahon, pers. comm. 1979; Whillans, pers. comm. 1979). In 1975, spawning occurred in the lagoons daily from May 21 to June 4 (Mahon and Balon 1977b); fishermen believe spawning may occur at three distinct times--early May, late May, and early June (Whillans, pers. comm. 1979). Carp enter the lagoons at the tip of Long Point (42°33', 80°05') to spawn, often in semi-isolated coves. All the fish collected in these areas were running ripe. Few young were collected in these areas; they apparently move out into the lake (Mahon 1979; Mahon and Balon 1977b). Young-of-the-year were collected in the Inner Bay (42°37', 80°22') marshes (Hamley and MacLean 1977), including Long Point Crown Marsh (42°35', 80°25') (Reid 1978). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') (Teleki 1976).

OE-5

Crescent Beach (possibly Crescent Park, 42°53', 78°58'). In 1929, carp larvae were found here June 29 (Fish 1932).

SILVERJAW MINNOW

Ohio

O-2

Rocky River (41°30', 81°50') and Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year were collected in the lower reaches of the rivers; these may be spawning areas (White et al. 1975).

SILVER CHUB

The silver chub, an endangered species in Lake Erie, entered rivers to spawn over clean gravel. Presently, they may spawn on beaches, because there are no suitable rivers remaining (White, pers. comm. 1979). Spawning occurred in June and the first week in July, and early larvae were commonly collected then throughout the lake (Fish 1932; Greeley 1929; Trautman 1957).

Ohio

O-1

Island Region (41°40', 82°45'). The silver chub spawned around the islands. In 1953, ripe females with running eggs were collected in late June in the open lake. Spawning occurred both in the open lake and in bay areas, but no specific sites were named. Spawning occurred from the second week in June to early August, at water temperatures of 66-74°F; peak spawning occurred in late June and early July at 73°F (Kinney 1954).

O-3

Grand River (41°46', 81°17'). In 1977, one individual in spawning condition was collected in the river in early June (White, pers. comm. 1979).

GOLDEN SHINER

Ohio

O-2

Cleveland (41°30', 81°43'). In 1972-74, fry and YOY golden shiners were abundant in Cleveland Harbor (41°31', 81°42') and were also collected in the lower Rocky River (41°30', 81°50'); these may be spawning areas (White et al. 1975).

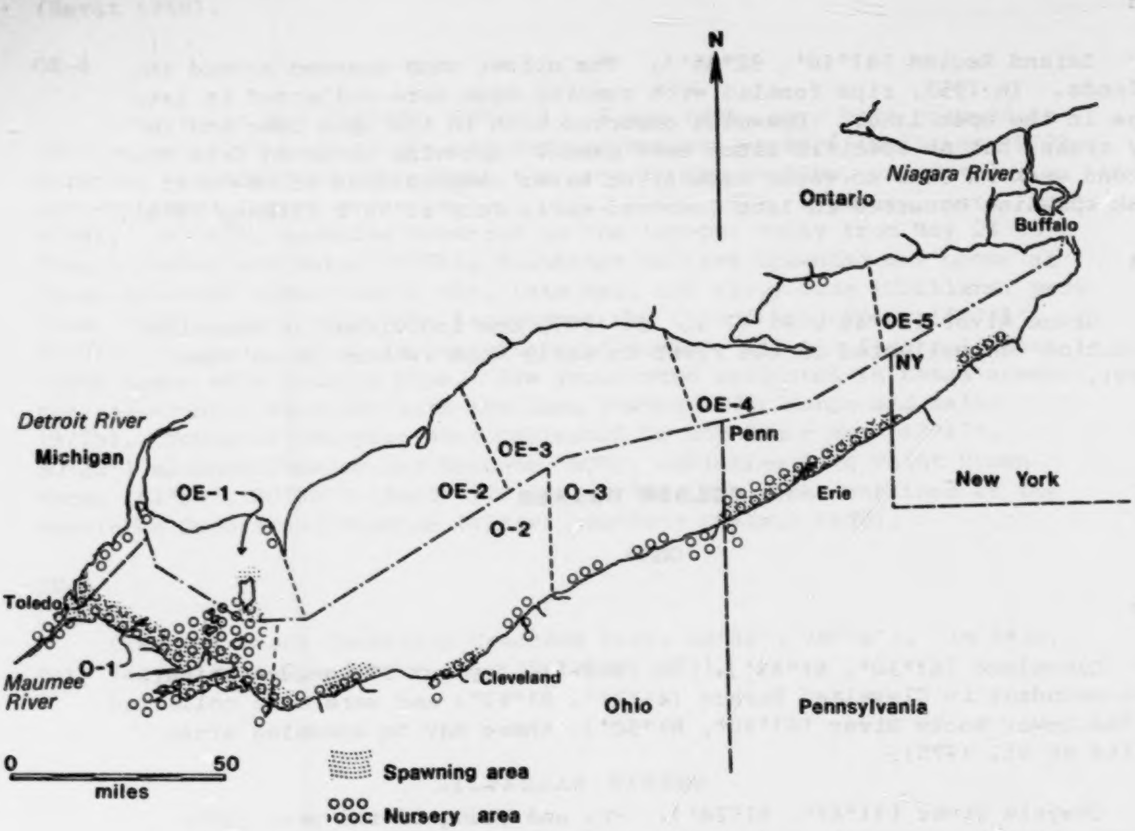
Chagrin River (41°41', 81°26'). Fry and young-of-the-year (YOY) golden shiners were collected at the mouth and adjacent shoreline of the river; these may be spawning areas (White et al. 1975).

Ontario

OE-4

Long Point (42°33', 80°10'). Spawning occurs in late May-early June in Long Point Crown Marsh (42°35', 80°25'), and YOY golden shiners are most numerous in July and August (Reid 1978). Reproducing populations also occur in the lagoons at the tip of the point (42°33', 80°05') (Mahon 1979).

EMERALD SHINER


N
Niagara River
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Penn
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Erie
New York
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In Lake Erie, emerald shiners spawn from mid- or late June to mid-August on the surface of the open lake or in areas of calm quiet water (Fish 1932; Langlois 1954). Fry first appear at the lake surface from mid-June to late July; large schools are present as far as 10 mi from shore (Flittner 1964; White, pers. comm. 1979). In 1928, only six emerald shiner larvae were found; these six larvae were collected in Long Point Bay (42°40', 80°10') in late July; however, in 1929 emerald shiner larvae were abundant throughout the lake from June to August, especially in the western basin (Fish 1932). Young-of-the-year (YOY) move off shore after reaching a length of about 2 in. and disperse throughout the lake (Flittner 1964).

The western basin is a major spawning and nursery area for Lake Erie emerald shiners (Doremus 1975); spawning occurs along the entire south shore of the basin over a sandy bottom (Wolfert, pers. comm. 1979). In 1958-60, spawning began first in Sandusky Bay (41°29', 82°46'), progressed along the south shore from Port Clinton (41°31', 82°56') east to Cedar Point Beach (41°29', 82°41'), and finally to the island area (41°40', 82°45') (Flittner 1964). In 1960, most larvae hatched during the first two weeks of July when the water temperature was about 75°F (Comm. Fish. Rev. 1961a); YOY first appear offshore in late July (Van Vooren and Davies 1974).

Emerald shiner larvae are most abundant in the open, less turbid offshore waters, often in deep waters adjacent to rocky reefs, particularly in the island region (Heniken 1977; Herdendorf et al. 1976; Waybrant and Shauver 1979).

Emerald shiners spawn in June and July in the quiet waters of rivers and harbors of the central basin. Extensive spawning also occurs 1/2 to 1-1/2 mi offshore. Prolarvae were collected 5 mi offshore, and postlarvae as far as 10 mi offshore (White, pers. comm. 1979).

Preliminary data suggest that the central basin contains one population of emerald shiners that spawns in rivers and harbors and a second population that spawns in the open lake (White, pers. comm. 1979). Young-of-the-year move offshore during early summer and then return inshore in large aggregations in the fall (Aquat. Ecol. Assoc. 1978c).

In the 1930s, spawning was observed in eastern Lake Erie several miles from shore, beginning in June. Ripe and running adults were found from May to August; peak spawning occurred in June and July. Eggs were found at depths as great as 30 ft, and YOY were collected offshore, from the surface to the 12 ft depth stratum (Cooper 1938).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1977, early postlarvae were abundant at the plant (Patterson 1979a). In 1975, early and late postlarvae were collected at the plant as late as August (Detroit Edison 1978).

Brest Bay (41°55', 83°18'). In 1977, early postlarvae were abundant offshore, in an area (41°55', 83°19') north of Sterling State Park (Patterson 1979a).

Monroe (41°55', 83°24'). Larvae were entrained at the Monroe Power Plant (41°53', 83°21') (Detroit Edison 1976h). Emerald shiner larvae were one of the most common larvae near the power plant from early June to early July (MacMillan 1976); YOY were common in October and November (Parkhurst 1971). In Michigan waters, large concentrations of YOY were present off Monroe (MDNR 1970-76).

Ohio

O-1

Maumee Bay (41°43', 83°25'). The Maumee River estuary (41°41', 83°28') is a nursery area (CLEAR 1977; Snyder 1978). Young-of-the-year were collected in large numbers in the eastern half of Maumee Bay in June (Herdendorf 1977; Herdendorf and Cooper 1975).

Potters Pond (41°41', 83°18'). Young-of-the-year were abundant off Potters Pond (Ayers et al. 1970).

Ward Canal (41°39', 83°14'). In 1977, postlarvae were abundant off Ward Canal (Patterson 1979a). In 1960, extensive spawning occurred in this area (Flittner 1964).

Crane Creek (41°38', 83°12'). In 1960, YOY were abundant at Crane Creek Beach in the fall (Woner 1963). Young-of-the-year are found throughout the summer and are especially abundant along shore in mid-August (Barnes and Reutter 1979; CLEAR 1976).

Locust Point (41°36', 83°05'). The most abundant fry at Locust Point are emerald shiners; spawning occurs in open water near the surface from late June to late July (Reutter and Herdendorf 1977; USNRC 1975a). Eggs and larvae 0.3-0.7 in. long dominate collections at the intake and discharge of the Davis Besse Power Station (41°36', 83°04') especially during late June and early July (CLEAR 1975a; Reutter 1979c; Reutter and Herdendorf 1977; USNRC 1975b).

Toussaint Reef (41°38', 83°01'). Prolarvae and postlarvae were present in large numbers at Toussaint Reef in early July (Reutter 1979c; Reutter and Herdendorf 1977).

Portage River (41°31', 82°56'). In 1960, extensive spawning was reported from the Portage River (referred to as the Clinton River) east to Catawba Point (41°35', 82°51') (Flittner 1964).

Catawba Island (41°35', 82°51'). In 1958, larvae were collected off Catawba Point (41°35', 82°51') during the second week of June (Flittner 1964). In 1969, YOY were abundant here (Gehres and Scholl 1969).

East Harbor (41°32', 82°47'). In 1970 and 1971, YOY were abundant inside and outside the harbor (Hair and Scholl 1971; Rudolph and Scholl 1970).

Island Region (41°40', 82°45'). Emerald shiner larvae are abundant in the area (Heniken 1977; Herdendorf et al. 1976). Young in various developmental stages, from postlarvae to juveniles are found among the islands. In the Bass Islands area, emerald shiners hatch in August (Hair 1979).

South Bass Island (41°39', 82°50'). In 1942, YOY were first caught near East Point (41°40', 82°48') on July 11 and the last ripe adults were collected on July 15. YOY were also collected near Gibralter Island (41°39', 82°49') in Put-In-Bay (41°39', 82°49') (Gray 1942). In 1958, newly hatched larvae about 0.2 in. long were collected during July and August. In 1959, spawning began near Put-In-Bay in the last week of June, whereas in 1960 spawning began in about mid-July (Flittner 1964). In 1975, larvae were found in May (Herdendorf et al. 1976.)

Starve Island (41°38', 82°49'). In 1942, fry were found southwest of the island (Gray 1942).

Middle Bass Island (41°41', 82°49'). In 1942, large concentrations of YOY were observed southeast of the island in 30-35 ft of water (Gray 1942).

North Bass Island (41°43', 82°49'). In 1975, larvae were found in May in the open waters northwest of the island (Herdendorf et al. 1976).

Kelleys Island (41°36', 82°42'). In 1942, large concentrations of larvae were collected east of the island in water 30-35 ft deep (Gray 1942). In 1958, larvae were also collected east of the island in August (Flittner 1964); in 1975, larvae were found in late June-early July (Herdendorf et al. 1976).

Gull Island (41°40', 82°41'). In 1942, YOY were collected south of Gull Island (Gray 1942).

Marblehead (41°32', 82°43'). In 1942, YOY were taken north of Marblehead Peninsula (Gray 1942).

Sandusky Bay (41°29', 82°46'). In 1958, larvae were collected at the surface during the second week of June. In 1960, spawning started in 10 ft of water on June 20 at a water temperature of 72°F; spawning decreased dramatically by July 20. Spawning was observed in the outer channel of the harbor (41°28', 82°43'); extensive spawning also occurred at Cedar Point Beach (41°29', 82°41') (Flittner 1964). In 1961-63 and in the 1970s, fry, 2.2-3.0 in. long were collected throughout the bay (Hartley 1975; Hartley and Herdendorf 1975; Keller 1964a). The Sandusky River estuary (41°27', 82°59') is a nursery area (CLEAR 1977).

O-2

Huron River (41°24', 82°33'). Large schools of fry were found in the lower river in 1976 (Cleveland Environ. Res. Group, undated).

Erie Nuclear Plant site (41°23', 82°30'). This is a major spawning and nursery area for emerald shiners (Wolfert, pers. comm. 1979). In 1974, larvae were abundant near the surface in July and August (Ohio Edison 1977). In 1974, YOY were also captured in this area in September in 10-33 ft of water over a bottom of shale bedrock covered by silt and clay (Wolfert, pers. comm. 1979).

Vermilion Harbor (41°26', 82°22'). In 1975, fry were collected from Vermilion Harbor on July 3 (U.S. Army Eng. Dist. Buffalo, 1976a), and the beach east of the river mouth is a nursery area (Cleveland Environ. Res. Group 1975).

Beaver Creek (41°26', 82°15'). In 1979, prespawning adults were collected at Oak Point Beach near the creek mouth and also farther offshore in mid-April and May. Gravid and spent females were first found in the area in July. Prolarvae were present in late May-July and postlarvae from late May to September out to the 36 ft depth contour (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). Spawning occurred in the harbor; adults were numerous in the spring and larvae were abundant after late June (Geo-Marine 1978). Spawning also occurs on the beaches in the harbor (Odin 1979).

Cleveland (41°30', 81°43'). Spawning occurs here; in 1972-74 fry and YOY were abundant in Cleveland Harbor (41°31', 81°42') (White et al. 1975; White, pers. comm. 1979). The beaches and breakwaters in the harbor are spawning and nursery areas (Odin 1979). Fry and YOY were also collected in the lower Rocky River (41°30', 81°50'); this may also be a spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). During 1972-74, fry and YOY were collected in the lower river; this may be a spawning area (White et al. 1975). Larvae were most abundant on the beaches around the river mouth; spawning probably occurs in these areas (Environ. Resour. Assoc. 1978).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, larvae were abundant in late June and early July; YOY were abundant along shore in late August (NUS 1975).

Ashtabula Harbor (41°55', 80°47'). There is significant production of larvae in Ashtabula Harbor (Hubbard 1977, as cited in Sweeney 1978). Emerald shiner larvae is one of the few larvae collected regularly here in the offshore waters (Sweeney 1978).

Turkey Creek (41°58', 80°32') and Conneaut River (41°58', 80°33'). The emerald shiner is a transient species in these streams; YOY were collected in these streams in the spring and fall (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Ripe adults were observed along the entire Pennsylvania shoreline in 42 ft or less of water in June. Fry were collected in this same area in 42 ft or less of water. Both adults and fry tend to move eastward due to the shoreline current (Kenyon, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). The emerald shiner is a transient species in the creek. In 1977, YOY were collected in the creek during the spring and fall; in 1978 they were present in the creek only in the spring (Aquat. Ecol. Assoc. 1978c).

New York

Dunkirk Harbor (42°30', 79°20'). The presence of gravid, ripe, and spent adults, eggs, prolarvae, and postlarvae indicates that spawning occurs in the harbor (Tex. Instrum. 1976a, as cited in Tex. Instrum. 1978;

Tex. Instrum. 1977d). In 1976, postlarvae were entrained at the Dunkirk Steam Station (42°30', 79°21') in August (Tex. Instrum. 1977e).

Van Buren Bay (42°27', 79°25'). Emerald shiners spawn from Van Buren Bay Creek (42°27', 79°24') to Canadaway Creek (42°28', 79°22') in 1-4 ft of water over a rock bottom. Eggs were collected from vegetation in this area; fry were collected here in August (Griswold and Galati, pers. comm. 1979).

Ontario

OE-1

Bar Point (42°03', 83°06'). In 1975, large numbers of YOY were collected along shore west of Bar Point off Highway 18 in August (Paine 1976).

Pelee Island (41°47', 82°40'). In 1959, extensive spawning occurred in South Bay (Harbor) (41°44', 82°39') over a sand bottom on July 16. Larvae about 0.2-0.3 in. long were collected from the southern tip of Fish Point (41°43', 82°40') east to South Harbor (Flittner 1964). In 1942, ripe adults were taken from the North wharf (41°49', 82°39') on July 28 (Gray 1942).

Point Pelee (41°55', 82°30'). In 1975, YOY were captured in beach seines off the west beach of Point Pelee (Paine 1976).

OE-4

Long Point Bay (42°40', 80°10'). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in July (Teleki 1976). In 1976, YOY were collected east and west of the Stelco Dock (42°47', 80°05') from July to September (Chamberlain 1976a). Young-of-the-year entered the limnetic areas after leaving the littoral nursery sites in late summer (Chamberlain 1976b).

COMMON SHINER

Spawning occurred in Lake Erie during June. In 1928, spawning adults and a large number of eggs and larvae were found in an unnamed tributary in mid-June (Fish 1932).

New York

Silver Creek (42°33', 79°10'). Spawning was observed in the creek over nests of the crested chub in clean gravel and strong current on July 9 at a water temperature of 83°F (Greeley 1929).

Cattaraugus Creek (42°34', 79°08'). Spent adults were collected in the creek on July 10 (Greeley 1929). It is not known if these fish were residents of the creek or migrants from the lake.

Ontario

OE-1

Point Pelee (41°55', 82°30'). In 1929, one larva was found in the lake south of Point Pelee and east of Pelee Island (41°47', 82°40') on June 19 (Fish 1932).

OE-4

Long Point (42°33', 80°10'). In 1929, numerous young-of-the-year were found at the tip of Long Point (42°33', 80°05') on July 8 (Fish 1932).

PUGNOSE MINNOW

Ohio

O-1

South Bass Island (41°39', 82°50'). This species migrated in large numbers to Put-In-Bay (41°39', 82°49') to spawn in mid-late April (Langlois 1954). Vegetation is required for successful spawning (Trautman, pers. comm. 1979).

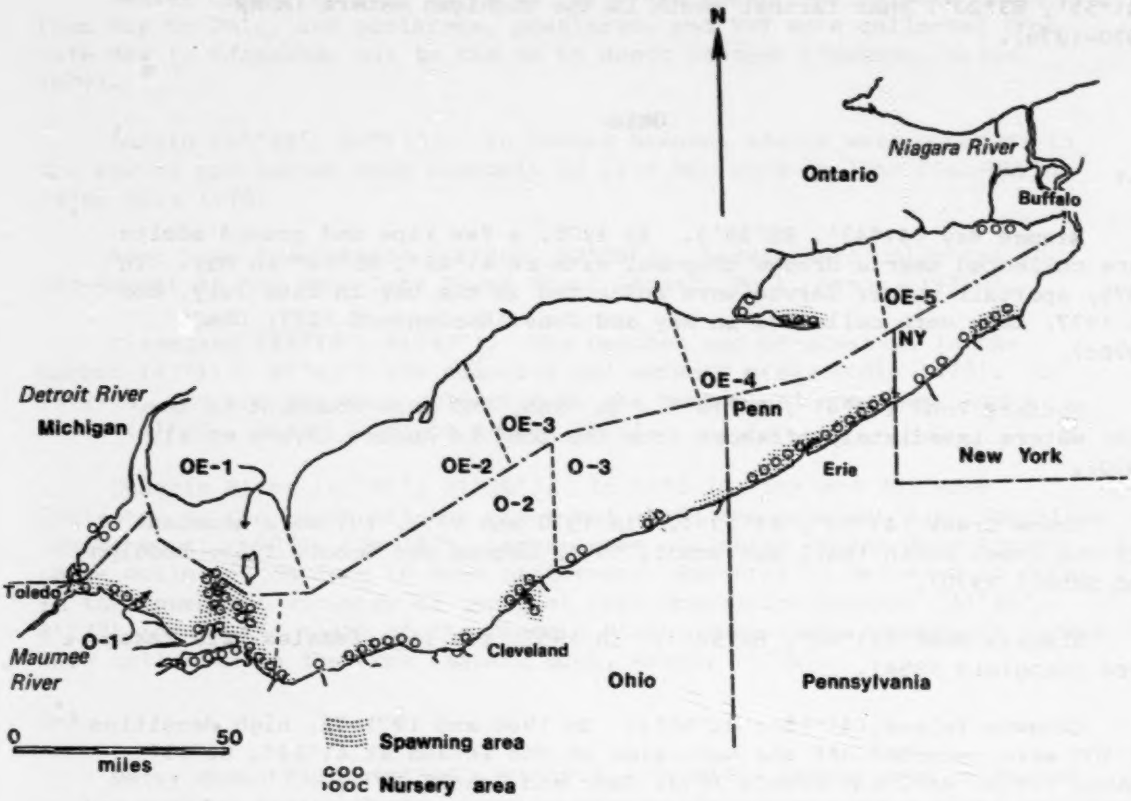
BLACKNOSE SHINER

Ontario

OE-4

Long Point (42°33', 80°10'). This species is believed to be established in lagoons at the tip of the point (42°33', 80°05'); young-of-the-year are numerous in these areas (Mahon 1979; Mahon and Balon 1977a).

SPOTTAIL SHINER


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
OE-2
O-3
New York
Erie
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

The western basin is the major spawning and nursery ground for spottail shiners (Doremus 1975). Spawning occurs over rocky areas around the islands and along the whole south shore, primarily within the 24 ft depth contour, in late June and early July (Greeley 1929; Heniken 1977; Waybrant and Shauver, undated; Wolfert, pers. comm. 1979). Many young-of-the-year (YOY) were collected from the Ohio waters of the western basin, beginning in late May to mid-June (Baker 1966b; Manz 1963; Van Vooren and Davies 1974; Van Vooren et al. 1977). In 1960, most larvae hatched from early to mid-June when the water temperature was about 68°F (Comm. Fish. Rev. 1961a). In the central basin, spottail shiners spawn over gravel on the beaches and in quiet river mouths. Larvae are most abundant on the beaches (Environ. Resour. Assoc. 1978).

Michigan

Monroe (41°55', 83°24'). Larvae were collected from the discharge canal of the Monroe Power Plant (41°53', 83°21') (Parkhurst 1971) and are one of the most common larvae in the area from early June to early July

(MacMillan 1976). In 1977, early postlarvae were found from early June to early July in Brest Bay at 41°56', 83°19' (Patterson 1979a). Trawl surveys showed YOY were more common off Monroe and Sterling State Park (41°55', 83°20') than farther south in the Michigan waters (MDNR 1970-1976).

Ohio

O-1

Maumee Bay (41°43', 83°25'). In 1975, a few ripe and gravid adults were collected near a dredge disposal site at 41°42', 83°26' in May. In 1975, spottail shiner larvae were collected in the bay in late July, and in 1977, they were collected in May and June (Herdendorf 1977; USACE 1976c).

Potters Pond (41°41', 83°18'). In 1965, YOY were abundant in the lake waters immediately offshore from the pond in August (Ayers et al. 1970).

Crane Creek (41°38', 83°12'). In 1970 and 1972, YOY were abundant off the creek mouth (Ball and Scholl 1973; Gehres and Scholl 1969; Rudolph and Scholl 1970).

Niagara Reef (41°40', 82°58'). In 1953, two ripe females were taken here (Langlois 1954).

Catawba Island (41°35', 82°51'). In 1966 and 1971-72, high densities of YOY were recorded off the west side of the island at 41°34', 82°53' (Baker 1967a; Ball and Scholl 1973; Hair and Scholl 1971).

East Harbor (41°32', 82°47'). In 1966-67 and 1970-72, YOY were abundant both inside and outside the harbor (Baker 1967a,c; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970).

Island Region (41°40', 82°45'). Larvae were collected around the Bass Islands (41°41', 82°49') and Kelleys Island (41°36', 82°42') (Heniken 1977). Young-of-the-year shiners were captured in June around the Bass Islands, especially on the west shore of South Bass Island (41°39', 82°50') (Kinney 1954; Langlois 1954).

Sandusky Bay (41°29', 82°46'). In 1961-63 and 1965, YOY, 0.3-3.0 in. long, were abundant in western Sandusky Bay during May-October (Baker 1966b; Keller 1964a), and YOY were fairly abundant at Cedar Point (41°29', 82°41') (Rudolph and Scholl 1970).

O-2

Vermilion River (41°26', 82°22'). In 1975, fry were collected in Vermilion Harbor in July (U.S. Army Eng. Dist., Buffalo, 1976a); the beach east of the Vermilion River mouth is a nursery area (Cleveland Environ. Res. Group 1975).

Beaver Creek (41°26', 82°15'). Ripe and spent females were collected from May to July, and prolarvae, postlarvae and YOY were collected from late May to September out to the 36 ft depth contour (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). In Lorain Harbor, adults were numerous in the spring and larvae were abundant in late May through June (Geo-Marine 1978; Odin 1979).

Avon Lake Power Plant (41°30', 82°03'). Larvae were collected in May-August at the Avon Lake Power Plant (Aquat. Ecol. Assoc. 1976c).

Cleveland (41°30', 81°43'). The beaches and breakwaters in the harbor (41°31', 81°42') are spawning and nursery areas (Odin 1979). In 1972-74, fry and YOY were collected in the harbor and the lower Rocky River (41°30', 81°50') (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, fry and YOY were collected at the mouth off the river and along the adjacent lake shoreline (White et al. 1975). In 1975, larvae were collected during June-August; those collected on June 10 were prolarvae. Spawning is believed to occur in the immediate vicinity of the East Lake Generating Station (41°40', 81°27') or in the mouth of the Chagrin River; only small numbers of larvae were collected in the area (Aquat. Ecol. Assoc. 1976b).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, larvae were collected in low numbers during June; spawning apparently occurs over a short period in June (NUS 1975).

Ashtabula (41°55', 80°47'). Spottail shiners spawn in protected water with gravel bottom off the Ashtabula power plants (41°55', 80°46'), between Piney Dock and a breakwall (White, pers. comm. 1979). Significant production of larvae occurs in Ashtabula Harbor (Hubbard 1977, as cited in Sweeney 1978).

Conneaut Harbor (41°58', 80°33'). Spottail shiners spawn on Cladophora beds and sandy areas along the east breakwall (Odin 1979).

Pennsylvania

Spottail shiners generally spawn all along the shore of Pennsylvania to depths of 42 ft but tend to concentrate in Outer Presque Isle Bay (Kenyon, pers. comm. 1979).

Outer Bay (42°09', 80°04'). Ripe adults and YOY were collected in this area in June (Kenyon, pers. comm. 1979).

New York

Barcelona (42°20', 79°36'). Young-of-the-year were collected in early July in water 1-4 ft deep over a bottom of rock and gravel; submergent vegetation was also present (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). In 1975, spottail shiner postlarvae were more abundant than those of most other species during June-August (Envirosphere 1977a).

Dunkirk Harbor (42°30', 79°20'). In 1976, spottail postlarvae were one of the most abundant species, especially in July (Tex. Instrum. 1977d). Postlarvae were also entrained at the Dunkirk Steam Station (42°30', 79°21') in July and August (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14'). Spottail shiner eggs were collected on vegetation in St. Colombian's region, near shore between Walnut (42°33', 79°10') and Eagle Bay (42°32', 79°14') creeks. Prolarvae and postlarvae were collected here in July and August, and YOY were taken from July to September. The bottom in this area is rock and gravel, and the water depth is 1-3 ft (Envirosphere 1977a,b; Griswold and Galati, pers. comm. 1979; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Sturgeon Point (42°41', 79°03'). In 1928, many ripe spottail shiners were collected here in mid-June (Fish 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Spottail shiners are believed to spawn in a large lagoon at the end of Long Point (42°33', 80°05'); in 1975, numerous YOY were collected there (Mahon and Balon 1977a). In 1975, YOY were found off Port Rowan (42°38', 80°27') in open lake littoral areas over sand and gravel in the fall (Suns and Rees 1978).

OE-5

Port Colborne (42°53', 79°15'). In 1975, YOY spottail shiners were collected in open lake littoral areas over sand and gravel bottom in the fall (Suns and Rees 1978).

ROSYFACE SHINER

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1961-63, young-of-the-year rosyface shiners, 1.2-1.8 in. long, were collected in western Sandusky Bay (Keller 1964a).

SPOTFIN SHINER

Ohio

O-1

South Bass Island (41°39', 82°50'). Spotfin shiners in spawning colors have been observed in weed beds near Terwilliger Pond (41°39', 82°50') (MacLean, pers. comm. 1979).

O-2

Rocky River (41°30', 81°50'). In 1972-74, fry and YOY were collected in the lower river; this may be a spawning area (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). In 1972-74, fry and young-of-the-year (YOY) spotfin shiners were collected in the mouth and adjacent shoreline of the Chagrin River; this may be a spawning area (White et al. 1975).

O-3

Ashtabula (41°55', 80°47'). Spotfin shiners spawn at the east side of the mouth of Ashtabula Harbor and deposit eggs in the crevices of various objects such as branches, pilings, and concrete. Spawning usually occurs in mid-July when the water temperature is above 70°F (White, pers. comm. 1979).

SAND SHINER

Sand shiners spawn in sheltered locations, such as creek mouths, and on sandy lake shoals in June and July (Greeley 1929; Langlois 1954).

Ohio

O-1

South Bass Island (41°39', 82°50'). Spawning sand shiners have been observed over gravel beaches on South Bass Island (Trautman, pers. comm. 1979).

O-2

Rocky River (41°30', 81°50') and Chagrin River (41°41', 81°26'). In 1972-74, fry and young-of-the-year (YOY) were collected in the lower reaches of the rivers; these might be spawning areas (White et al. 1975).

O-3

Ashtabula (41°55', 80°47'). Sand shiners spawn on sandbars in Ashtabula Harbor in mid-July when the water temperature rises above 70°F (White, pers. comm. 1979).

New York

Muddy Creek (42°37', 79°06'). In 1928, some larvae were collected at the creek mouth in late July (Fish 1932).

Sturgeon Point (42°41', 79°03'). In 1929, larvae were abundant from the Sturgeon Point area over to Port Dover beginning in early August (Fish 1932).

Ontario

OE-1

Point Pelee (41°55', 82°30'). In 1929, larvae and postlarvae were abundant around Point Pelee in August (Fish 1932).

OE-4

Long Point Bay (42°40', 80°10'). Numerous YOY have been found in a large lagoon at the tip of Long Point (42°33', 80°05'), and spawning is believed to have occurred in the lagoon (Mahon and Balon 1977a). In 1929, larvae and postlarvae became abundant in early August from the Port Dover area (42°47', 80°12') over to Sturgeon Point, New York (42°41', 79°03') (Fish 1932).

OE-5

In 1929, larvae were abundant throughout the area from Port Dover (42°47', 80°12') to Sturgeon Point (42°41', 79°03') (Fish 1932).

MIMIC SHINER

Ohio

Spawning occurs over silt-free sand (White et al. 1975).

O-1

South Bass Island (41°39', 82°50'). Mimic shiners spawn around South Bass Island in silt-free, quiet water (Trautman, pers. comm. 1979). Larvae less than 1 in. long were commonly found in the Stone Cove area (41°38', 82°51') in September (Kinney 1954).

Sandusky Bay (41°29', 82°46'). Larvae less than 1 in. long were commonly collected in Sandusky Bay during September (Kinney 1954).

O-3

Ashtabula (41°55', 80°47'). A few mimic shiners spawn on sand bars in Ashtabula Harbor (White, pers. comm. 1979).

NORTHERN REDBELLY DACE

Ohio

This species enters the streams of northern Ohio to spawn on riffles in April and May. The adults return to Lake Erie by July 1 (McCormick 1892).

BLUNTNOSE MINNOW

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1961, young-of-the-year (YOY) were collected in small numbers from May to October (Keller 1964a).

O-2

The bluntnose minnow spawns in protected waters of the central basin, such as harbors and lower sections of rivers (White, pers. comm. 1979).

Rocky River (41°30', 81°50'), Cleveland Harbor (41°31', 81°42') and Chagrin River (41°41', 81°26'). In 1972-74, YOY were common in the harbor and the lower reaches of the rivers; these might be spawning areas (White et al. 1975).

New York

Sister Creek (42°40', 79°04'). In 1928, eggs and young were found in a nest guarded by a male under a flat stone near the creek mouth on July 13 at a water temperature of 82°F (Fish 1932; Greeley 1929).

Ontario

OE-4

Long Point (42°33', 80°10'). The bluntnose minnow spawns in late May and early June in Long Point Crown Marsh (42°35', 80°25'); YOY are common here (Reid 1978). Reproducing populations are established in the lagoons at the end of the point (42°33', 80°05'), and YOY are numerous in these lagoons (Mahon 1977a, 1979).

FATHEAD MINNOW

Ohio

O-2

Cleveland Harbor (41°31', 81°42'). In 1972-74, young-of-the-year were collected in the harbor in small numbers; this may be a spawning area (White et al. 1975).

LONGNOSE DACE

In Lake Erie, the longnose dace spawns in streams and along wave-washed beaches from Sandusky eastward (Trautman, pers. comm. 1979) in the habitat it occupies throughout the year (White, pers. comm. 1979).

Ohio

Along the Ohio shoreline, ripe adults are present and spawning occurs along the beach from Lakewood (41°30', 81°47') to Conneaut (41°58', 80°33'), where the substrate is composed of rocks of approximately 4 in. diameter; larvae are found in this same area (White, pers. comm. 1979).

O-2

Beaver Creek (41°26', 82°15'). In 1979, five YOY were seined at Oak Point Beach near the creek mouth on July 24 (Commonw. Assoc. 1979).

Lakewood (41°30', 81°47'). The beach approximately 3-1/2 mi E of the mouth of the Rocky River (41°30', 81°50') is an excellent spawning site (White, pers. comm. 1979).

Cleveland Harbor (41°31', 81°42'). The beaches and breakwaters here are spawning and nursery areas (Odin 1979). Young-of-the-year (YOY) were also collected here (White, pers. comm. 1979).

Gordon Park (41°33', 81°38'). The area just east of the Cleveland Municipal Boat Docks is a spawning area (White, pers. comm. 1979).

Moss Point (41°37', 81°31'). This is a probable spawning site (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Postlarvae were collected from the lower river; the area just east of the river mouth is a spawning site (White, pers. comm. 1979).

O-3

Ashtabula (41°55', 80°47'). Spawning occurs both inside and outside the harbor (White, pers. comm. 1979).

Conneaut Harbor (41°58', 80°33'). Spawning occurs here (White, pers. comm. 1979).

Pennsylvania

Collections of gravid males and females suggest spawning occurs in May in the surge zone along the entire Pennsylvania shoreline. The surge zone, at a depth of 1 ft, has rock bottom, moderate-strong current, and no vegetation. The longnose dace probably inhabits this shoreline area throughout the year (Kenyon, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10'). Young-of-the-year were seen here in late summer in sandy pools along the south shore of Long Point (Mahon, pers. comm. 1979).

CREEK CHUB

Ohio

O-2

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year were collected in the lower river; this may be a spawning area (White et al. 1975).

SHINER spp.

Michigan

Woodtick Peninsula (41°44', 83°25'). Larvae of shiners were found in high densities in 6-12 ft of water off the Woodtick Peninsula at 41°46', 83°25' in late June and early July and were either spottail or emerald shiners (Waybrant and Shauver 1979). In 1978, at the Whiting Power Plant (41°47', 83°27'), larvae of shiners were collected in the bay; peak catches occurred in June. Larvae were first entrained in May; peak entrainment occurred in July (Wapora 1979b).

Ohio

O-2

Avon Lake Power Plant (41°30', 82°03'). In 1977-78, up to 97% of the larvae caught here in the spring and summer were spottail and emerald shiners (Applied Biology 1979c).

Cleveland (41°30', 81°43'). In 1977-78, 12% of the larvae entrained at the Lakeshore Power Plant (41°32', 81°38') were spottail and emerald shiners (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). In 1977-78, emerald and spottail shiner larvae were the most abundant larvae present at the Eastlake Power Plant (41°40', 81°27') in the spring; they were entrained June-August (Applied Biology 1979b).

O-3

Ashtabula Harbor (41°55', 80°47'). In 1977-78, shiners were among the most abundant fishes present and entrained at the Ashtabula power plants (41°55', 80°46'). Shiner larvae were present from May to August; they were 53% of the larvae collected annually and 75% of the larvae collected during the summer (Applied Biology 1979d,e).

New York

Van Buren Bay (42°27', 79°25'). In 1975-76, many shiner eggs, prolarvae, postlarvae, and YOY were abundant in the lake off the bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1976, shiner eggs, prolarvae, and postlarvae were collected in the harbor from June to August (Tex. Instrum. 1977d), and entrained at the Dunkirk steam station (42°30', 79°21') (Tex. Instrum. 1977e). Eggs were entrained in June and July and prolarvae and postlarvae were entrained from June to August (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14'). Shiner eggs, prolarvae, postlarvae, and young-of-the-year (YOY) were found in the lake off the bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

MINNOW spp.

Ohio

O-2

Avon Lake Power Plant (41°30', 82°03'). Minnow larvae were entrained in May and were 12% of the total entrained from April to June (Applied Biology 1979c).

O-3

Conneaut (41°58', 80°33'). In 1977, many minnow eggs were collected in Lake Erie near shore between Conneaut and Raccoon Creek (41°59', 80°29'), in Conneaut Harbor (41°58', 80°33'), and approximately 1/2 mi offshore at Turkey Creek (41°58', 80°32') from June to August. Larvae were collected nearshore between Conneaut and Raccoon Creek and in Conneaut Harbor from late May through August. Large numbers of larvae were also collected in the Conneaut River (41°58', 80°33') and Turkey Creek (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Raccoon Creek (41°59', 80°29'). In 1977, many minnow larvae were collected in the creek (Aquat. Ecol. Assoc. 1978c).

New York

Eagle Bay (42°32', 79°14'). In 1975, eggs of carp, goldfish, and their hybrids were found at the 10 ft and 30 ft contours in early June. Prolarvae and postlarvae were very abundant in mid-May through July; prolarvae dominated surface collections (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undatd a).

CYPRINID spp.

Michigan

Raisin River (41°53', 83°20'). Larvae of carp, goldfish, and their hybrids are more abundant in the river than in the surrounding lake (Cole 1978b); this is one of the most abundant species present in the area from May to July (MacMillan 1976).

New York

Van Buren Bay (42°27', 79°25'). In 1976, carp-goldfish prolarvae were collected in mid-June through July; postlarvae were collected in late June (Tex. Instrum. 1977a).

Dunkirk Harbor (42°30', 79°20'). In 1976, eggs of carp, goldfish, and their hybrids were present during June and July, peaking on June 14. Prolarvae were very abundant and were present during June through August, peaking in mid-June, near the bottom. Postlarvae were collected in June through August (Tex. Instrum. 1977d,e).

RIVER CARPSUCKER

Ohio

O-2

Lorain Harbor (41°28', 82°11'). A few larvae were found in the harbor (Geo-Marine 1978).

QUILLBACK

Two populations of the quillback exist in the Lake Erie drainage basin; a lake-run quillback and a riverine quillback. The lake-run quillback migrates into harbors and lower rivers to spawn and scatters its eggs over vegetation or gravel. The riverine quillback inhabits rivers and migrates further upstream to spawn in very small tributaries (White, pers. comm. 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). A major spawning area is located on the shoal north of Cedar Point at 41°43', 83°21'; spawning occurs over a sand bottom at depths of 1-6 ft, during May (Reynolds, pers. comm. 1979). From June 10 to July 10, spawning occurs nearshore at 41°42', 83°24' approximately 2-1/2 mi E of the Maumee River (Pinsak and Meyer 1976).

Sandusky Bay (41°29', 82°46'). Spawning occurs in the bay (FWS 1979d).

O-2

Cranberry Creek (41°23', 82°29'). In 1974, quillback larvae were abundant near Cranberry Creek on June 19 (Ohio Edison 1977).

Lorain Harbor (41°28', 82°11'). Larvae were collected in Lorain Harbor (Geo-Marine 1978).

Cleveland (41°30', 81°43'). Spawning runs enter the Rocky River (41°30', 81°50') and Cleveland Harbor (41°31', 81°42'). Many migrating adults were collected in the Rocky River over a 3-day period during the latter part of May. Quillbacks also migrated into Cleveland Harbor (White, pers. comm. 1979). In 1972-1974, larvae and YOY were collected in the Rocky River, Cleveland Harbor, and along the adjacent lakeshore (White et al. 1975).

Chagrin River (41°41', 81°26'). A spawning run enters the river in mid-May. Larvae and young-of-the-year (YOY) were found in the river and along adjacent shorelines (Environ. Resour. Assoc. 1978; White, pers. comm. 1979; White et al. 1975).

New York

Cattaraugus Creek (42°34', 79°08'). In the late 1920s, many quillbacks were seined in the creek in the spring, and young were abundant along shallow mud flats several miles upstream from the mouth (Greeley 1929).

Sister Creek (42°40', 79°04'). In the late 1920s, one very young fry was found at the creek mouth in mid-July (Greeley 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Quillbacks migrate through Inner Bay (42°37', 80°22') to spawn. Big Creek (42°36', 80°27') and the Turkey Point area (42°39', 80°21') have spawning runs in the spring (Whillans 1977).

LONGNOSE SUCKER

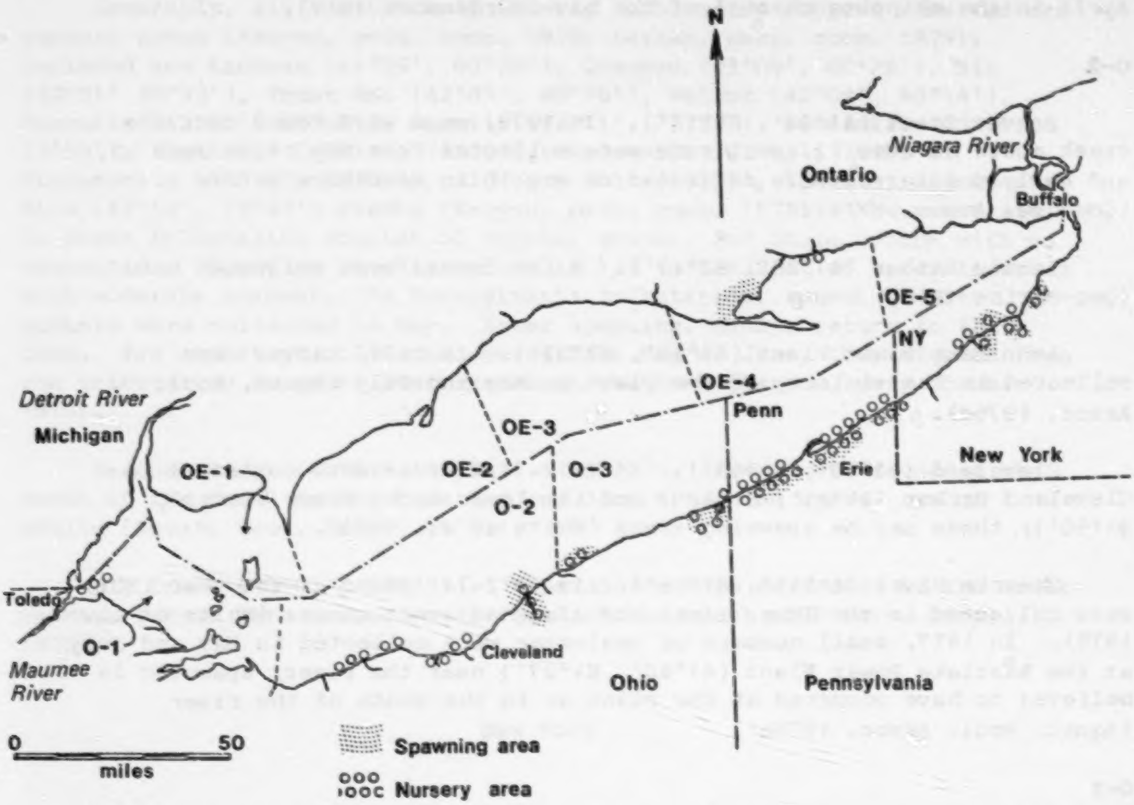
Ohio

Longnose suckers spawn on beaches and current-swept shoals over gravel (White, pers. comm. 1979).

O-1

The longnose sucker moves into water less than 25 ft deep during the spring, presumably to spawn around reefs (Trautman 1957).

WHITE SUCKER


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
New York
OE-1
OE-2
O-3
Erie
O-2
Toledo
O-1
Cleveland
Maumee River
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In Lake Erie, white suckers spawn in tributaries in April or May, soon after ice breakup, and then return to the shallow nearshore waters of the lake (Fish 1932; FWS 1979d; Langlois 1954). Spawning also occurs in the lake; many fry were found alongshore far from tributary mouths (Applegate and Van Meter 1970; Greeley 1929). In 1928, fry about 0.6-1.0 in. long were abundant in shallow water at the east end of the lake from mid-June to mid-July (Fish 1932). The decline of suckers in Lake Erie was partly caused by destruction or blocking of the preferred spawning grounds in streams (USDI 1967).

Ohio

Along the Ohio shoreline of the central basin, white suckers spawn at night in almost all tributaries that have gravel or rubble riffles; they also spawn on gravel bars and beaches in the lake where there is suitable current. Adults only remain in the tributaries for a few days, then return to the lake (White, pers. comm. 1979). The earliest runs occur in late March (Cleveland Environ. Res. Group, undated).

O-1

Maumee Bay (41°43', 83°25'). In 1977, a few larvae were collected in April in the shipping channel of the bay (Herdendorf 1977).

O-2

Beaver Creek (41°26', 82°15'). In 1979, eggs were found near the creek mouth on June 12, prolarvae were collected from May 10 to June 12, and early postlarvae were collected on May 10 in nearshore waters (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). A few larvae were collected here (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, larvae were collected in the vicinity of the plant in May and July (Aquat. Ecol. Assoc. 1976c).

Cleveland (41°30', 81°43'). In 1972-74, larvae were collected in Cleveland Harbor (41°31', 81°42') and the lower Rocky River (41°30', 81°50'); these may be spawning areas (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year (YOY) were collected in the lower river and along adjacent shores (White et al. 1975). In 1977, small numbers of prolarvae were collected in May and July at the Eastlake Power Plant (41°40', 81°27') near the river; spawning is believed to have occurred at the plant or in the mouth of the river (Aquat. Ecol. Assoc. 1976b).

O-3

Perry Power Plant (41°48', 81°09'). Spawning occurs in the area during early spring; in 1974, early larvae were collected in the vicinity of the plant (NUS 1975).

Conneaut River (41°58', 80°33'). In 1977-78, ripe adults were captured in the river during spawning runs; eggs were found in the river in late April, prolarvae were taken at the river mouth, and YOY were collected in the river in September (Aquat. Ecol. Assoc. 1978c).

Turkey Creek (41°58', 80°32'). Spawning occurs during April and May (USACE, undated b). In 1977-78, ripe adults were captured during spawning runs; eggs were found in April and May at water temperatures of about 50-55°F. Larvae were collected at the creek mouth and also 1/2 mi offshore in early June; YOY were also collected in the creek (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Generally, all continuously flowing tributaries support runs and are nursery areas (Kenyon, pers. comm. 1979; Larsen, pers. comm. 1979); included are Raccoon (41°59', 80°29'), Crooked (42°00', 80°26'), Elk (42°01'·80°22'), Trout Run (42°03', 80°16'), Walnut (42°04', 80°14'), Fourmile (42°09', 80°02'), Sixmile (42°11', 79°59'), Sevenmile (42°11', 79°59'), Eightmile (42°11', 79°58'), Twelvemile (42°13', 79°55'), Sixteenmile (42°14', 79°50'), Eighteen Mile (42°15', 79°48'), and Twenty Mile (42°16', 79°47') creeks (Kenyon, pers. comm. 1979). The substrate in these tributaries consist of rubble, gravel, and shale bottom with no vegetation. Spawning usually occurs in 1/2 to 1-1/2 ft of water in areas with moderate current. In Pennsylvania tributaries, spawning white suckers were collected in May. After spawning, adults return to the lake. Fry are first collected during late May or June; they migrate from the tributaries to rocky beach areas in the lake (Kenyon, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). In 1977, larvae were found at the mouth of the creek during late May and June after the spring run of adults (Aquat. Ecol. Assoc. 1978c).

Elk Creek (42°01', 80°22'). Ripe adults were collected in the creek in May; larvae were subsequently found in the creek (GPU Serv. Corp. 1979).

New York

Van Buren Bay (42°27', 79°25'). In 1976, postlarvae were collected in the bay (Tex. Instrum. 1977a).

Canadaway Creek (42°28', 79°22'). White suckers spawn in the creek over rocky gravel bottom in 2-4 ft of water; YOY were collected in the creek from July to October (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 79°20'). In 1976, prolarvae were collected in May (Tex. Instrum. 1977d).

Eagle Bay (42°32', 79°14'). In 1976, postlarvae were collected from the bay (Tex. Instrum. 1977a).

Silver Creek (42°33', 79°10'). White suckers spawn in the creek over stone and gravel in 2-4 ft of water; YOY were collected in the creek in July and August (Griswold and Galati, pers. comm. 1979).

Delaware Creek (42°38', 79°04'). This is assumed to be a spawning and nursery area; YOY were collected in the creek in July and August (Griswold and Galati, pers. comm. 1979).

Big Sister Creek (42°40', 79°04'). Spawning occurs over rock and gravel in 2-4 ft of water; YOY were collected in the creek (Griswold and Galati, pers. comm. 1979).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). White suckers migrate through Inner Bay (42°37', 80°22') to spawn. Major spawning runs occur in the Turkey Point area (42°39', 80°21'), in the lower reaches of Big Creek (42°36', 80°27'), and in many small creeks (Whillans 1977, pers. comm. 1979). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') during June 6-12 and June 21-27 (Teleki 1976).

CREEK CHUBSUCKER

Ohio

O-2

Avon Lake Power Plant (41°30', 82°03'). In 1975, larvae were collected at the plant in May and July (Aquat. Ecol. Assoc. 1976c).

Chagrin River (41°41', 81°26'). In 1975, small numbers of eggs and prolarvae were collected at the Eastlake Power Plant (41°40', 81°27') near the river in May, June, and August. Spawning is thought to occur in the immediate area, probably in the river or at its mouth (Aquat. Ecol. Assoc. 1976b).

LAKE CHUBSUCKER

Ontario

OE-4

Long Point Bay (42°40', 80°10'). This is probably the only area in Canada where lake chubsuckers are common (Mahon, pers. comm. 1979). Adults migrate through Inner Bay (42°37', 80°22') to spawn in mid- to late April in Long Point Crown Marsh (42°35', 80°25'), the lower reaches of Big Creek (42°36', 80°27'), and the Turkey Point area (42°39', 80°21') (Reid 1978; Whillans 1977). Large numbers of young-of-the-year were seen in late summer in a muddy, vegetated lagoon on Long Point (42°33', 80°10'); reproducing populations are probably established in the lagoons (Mahon 1979, pers. comm. 1979).

NORTHERN HOG SUCKER

Young of this species were found along Lake Erie shores near stream mouths but were more common in shallow, warm creeks and rivers (Fish 1932).

Ohio

O-3

Turkey Creek (41°58', 80°32'). Adults were found in the creek during April and May; this may have been a spawning run (USACE, undated b).

BIGMOUTH BUFFALO

Michigan

Swan Creek (41°58', 83°15'). Until 1968, spawning occurred in an area (41°58', 83°10') 3 mi E of the mouth of the creek over mud and rock in 9-12 ft of water (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Since 1958, spawning has occurred over gravel in water shallower than about 6 ft along the shore from 41°49', 83°26' south to North Cape (41°44', 83°25') (Organ et al. 1978).

Bay Creek (41°47', 83°27'). Since 1952, spawning has occurred at the mouth of the creek over mud bottom (Organ et al. 1978).

Indian Island (41°45, 83°27'). Since 1950, spawning has occurred over mud in the area surrounding the island (Organ et al. 1978).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Spawning occurs from mid-June to mid-July in the shallow, warm nearshore areas of Maumee Bay from an area north of the mouth of the Maumee River at 41°43', 83°27' to Cedar Point (41°42', 83°20') (Pinsak and Meyer 1976).

Sandusky Bay (41°29', 82°46'). A resident population ascended tributaries to spawn in late March-May (Trautman 1957).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Bigmouth buffalo migrate through Inner Bay (42°37', 80°22') to spawn. Big Creek (42°36', 80°27') and the Turkey Point area (42°39', 80°21') have spawning runs in the spring (Whillans 1977).

SILVER REDHORSE

Spawning runs ascend tributary streams as the ice goes out (Greeley 1929); the young are generally found at creek mouths (Fish 1932). Historically, this species ran into all the rivers of the central basin (White, pers. comm. 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Spawning occurs during April 1-May 10 in an area (41°41', 83°28') just west of the mouth of the Maumee River and in an area (41°42', 83°26') along the shipping channel (Pinsak and Meyer 1976).

O-3

Grand River (41°46', 81°17'). A spawning run presently enters the river; adults with breeding tubercles were collected in the river (White, pers. comm. 1979).

Pennsylvania

Elk Creek (42°01', 80°22'). Many ripe adults were collected in the creek in May; these had probably entered the creek from the lake (GPU Serv. Corp. 1979).

New York

During the late 1920s, young-of-the-year (YOY) were found at the mouths of several unnamed tributaries (Greeley 1929).

Cattaraugus Creek (42°34', 79°08'). In the late 1920s, runs entered the creek (Greeley 1929).

Eighteenmile Creek (42°43', 78°58'). In the late 1920s, YOY were found at the creek mouth (Greeley 1929).

BLACK REDHORSE

Ohio

Spawning runs entered all the rivers along the northeastern Ohio shoreline (White, pers. comm. 1979).

O-2

Chagrin River (41°41', 81°26'). Spawning runs enter the river. Adults with breeding tubercles were collected in the river. Larvae were found in an upstream backwater, the lower river, and at the river mouth (Environ. Resour. Assoc. 1978; White, pers. comm. 1979; White et al. 1975).

O-3

Grand River (41°46', 81°17'). A spawning run enters the river; adults with breeding tubercles were collected in the river (White, pers. comm. 1979).

New York

Eighteenmile Creek (42°43', 78°58'). Small (age not given) black redhorses were numerous at the mouth of the creek (Greeley 1929).

GOLDEN REDHORSE

Ohio

O-1

Maumee Bay (41°43', 83°25'). Spawning is believed to occur during April 1-May 10 in an area (41°41', 83°28') just west of the mouth of the Maumee River and in an area (41°42', 83°26') along the shipping channel (Pinsak and Meyer 1976).

O-2

Rocky River (41°30', 81°50'). In 1972-74, fry and young-of-the-year were collected from the lower river and adjacent shorelines; the river may be a spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). A spawning run enters the river. Larvae were found in upstream backwater areas, in the lower river, and at the river mouth from mid-May to mid-June (Environ. Resour. Assoc. 1978; White et al. 1975).

O-3

Turkey Creek (41°58', 80°32'). Adults were collected in April and May; these fish may have entered the creek from the lake (USACE, undated b).

Pennsylvania

Elk Creek (42°01', 80°22'). Ripe adults were collected in May at the creek mouth (GPU Serv. Corp. 1979).

SHORTHEAD REDHORSE

Small runs enter Lake Erie tributaries in the spring (Langlois 1954; Trautman 1957).

Ohio

O-1

Maumee Bay (41°43', 83°28'). Spawning occurs during April 1-May 10 in an area (41°41', 83°28') just west of the mouth of the Maumee River and in an area (41°42', 83°26') along the shipping channel (Pinsak and Meyer 1976).

O-2

Cuyahoga River (41°30', 81°43'). In the late 1800s, adults congregated on riffles with rapid current in the river; they migrated into the river in April, before the ice was out, and returned to the lake by mid-May (McCormick 1892).

O-3

Turkey Creek (41°58', 80°32'). Adults were collected in the creek in April and May; these fish may have entered the creek from the lake (USACE, undated b).

New York

Cataraugus Creek (42°34', 79°08'). In the late 1920s, spawning runs entered the creek in May (Greeley 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Adults migrate through Inner Bay (42°37', 80°22') to spawn in the lower reaches of Big Creek (42°36', 80°27') and in the Turkey Point area (42°39', 80°21') (Whillans 1977). The runs in Big Creek were very large during the early 1940s; these runs declined between 1945 and 1950 and have not recovered (Whillans, pers. comm. 1979). In 1974, young-of-the-year were entrained at the Nanticoke Generating Station (42°48', 80°03') (Teleki 1976).

CATOSTOMID spp.

Historically, unidentified species of suckers entered streams in the eastern basin in the spring, remained for no more than 3 weeks, and then returned to the lake (Kerr and Kerr 1860-1898). Runs still enter tributaries; spawning may also occur in the lake (Applegate and Van Meter 1970; USBCF 1966).

Michigan

Huron River (42°02', 83°12'). Suckers enter the river to spawn. In 1979, the run peaked in mid-April (UPI 1979).

Pointe Mouillee (42°01', 83°12'). Spawning runs occurred here in early spring (Warren 1946).

Swan Creek (41°58', 83°15'). In 1976, larvae were collected along shore in an area (41°59', 83°14') just north of the mouth of Swan Creek in late April-early May (Waybrant and Shauver 1979).

Woodchuck Creek (41°51', 83°24')--La Plaisance Creek (41°52', 83°23'). Suckers spawn here close to shore over gravel (Organ et al. 1978).

Otter Creek (41°51', 83°24'). Suckers spawn over mud in the embayment at the creek mouth (Organ et al. 1978).

Ohio

O-3

Conneaut (41°58', 80°33'). In 1977, unidentified sucker larvae were collected in April, June, and August; these larvae probably originated from spawning that occurred in the tributaries between Conneaut and Raccoon Creek (41°59', 80°29'). Sucker larvae were collected in the Conneaut River (41°58', 80°33') in late April and early June, at the mouth of Turkey Creek (41°58', 80°32') in June, and in Conneaut Harbor (41°58', 80°33') (Aquat. Ecol. Assoc. 1978c).

Ontario

Runs entered the following Ontario tributaries (Kerr and Kerr 1860-1898).

OE-4

Big Creek (42°36', 80°27'). In the late 1800s, many suckers were still entering the creek, even though a dam had been built that curtailed the run.

Nanticoke Creek (42°48', 80°04'). In 1886, a run of suckers and "mullet" occurred in late March, but this run was curtailed by a dam.

OE-5

Grand River (42°51', 79°35'). In 1890, a large run of suckers and mullet occurred.

BLACK BULLHEAD

Black bullheads are common in the central basin of Lake Erie. They spawn in harbors, where they make nests in breakwalls, or in rivers with overhung banks or much deadfall (White, pers. comm. 1979).

Ohio

O-1

Magee Marsh (41°37', 83°10'). In 1952, schools of young were observed in the channels of the marsh during late July (Langlois 1954).

Sandusky Bay (41°29', 82°46'). In 1953-54, black bullheads entered Sandusky Bay to spawn in the spring and returned to the lake in the summer and fall. Young-of-the-year (YOY) were collected throughout most of the bay, and were most abundant in protected waters with aquatic vegetation (Chapman 1955; Keller 1964b).

O-2

Vermilion River (41°26', 82°22'). A spawning run enters the river in July and August (U.S. Army Eng. Dist., Buffalo, 1976a).

Rocky River (41°30', 81°50'). A spawning run enters the river in early May (Cleveland Environ. Res. Group, undated).

Chagrin River (41°41', 81°26'). During 1972-74, YOY or fry were collected in the lower Chagrin River and adjacent shoreline areas; this is probably a spawning area (White et al. 1975).

YELLOW BULLHEAD

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1953-54, yellow bullheads entered Sandusky Bay to spawn in the spring and returned to Lake Erie in the summer and fall. Spawning occurred during late spring and early summer. Young-of-the-year (YOY) were found throughout most of Sandusky Bay, and were most abundant in protected waters with aquatic vegetation (Chapman 1955).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Young-of-the-year were seined from the marshes of Inner Bay (42°37', 80°22') (Hamley and MacLean 1979), and reproducing populations are probably established in the lagoons on Long Point (42°33', 80°10') (Mahon 1979).

BROWN BULLHEAD

In the central basin, brown bullheads spawn in harbors, where they build nests in breakwalls, and in rivers with overhung banks and submerged fallen trees (White, pers. comm. 1979). In the western basin, brown bullheads are present mainly in the marshlands and near marinas (Wolfert, pers. comm. 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Brown bullheads are believed to spawn in an area (41°41', 83°22') about 1-1/2 mi SW of Cedar Point (41°42', 83°20'); spawning occurs along shore in 3 ft of water from June 1 to July 15 (Pinsak and Meyer 1976).

Magee Marsh (41°37', 83°10'). In 1952, YOY were collected in a channel of the marsh in late July (Langlois 1954).

South Bass Island (41°39', 82°50'). Brown bullheads spawn at the mouth of Terwilliger Pond (41°39', 82°50'); males were observed guarding fry in this area (MacLean, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). In 1953-54, brown bullheads migrated into Sandusky Bay in the spring and spawned in the late spring and early summer. In the summer and fall, there was a return migration from Sandusky Bay into Lake Erie. Young-of-the-year (YOY) were found throughout most of Sandusky Bay, but were most abundant in protected waters with aquatic vegetation (Chapman 1955; Keller 1964a).

O-2

Old Woman Creek (41°23', 82°31'). The lower reaches of the creek contain excellent spawning habitat (FWS 1979d).

Vermilion River (41°26', 82°22'). Brown bullheads migrate from Lake Erie into the river to spawn in July and August (U.S. Army Eng. Dist., Buffalo, 1976a).

Rocky River (41°30', 81°50'). A spawning migration enters the river in early May (Cleveland Environ. Res Group, undated), and fry and YOY have been found in the river (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, fry and YOY were collected in the lower Chagrin River and adjacent shorelines; this might be a spawning area (White et al. 1975).

O-3

Turkey Creek (41°58', 80°32'). Adults are found in the creek in April and May; these fish may have entered the creek from the lake (USACE, undated b).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Gravid females from a resident population were collected during April. Adults were also collected in the

Outer Bay area (42°09', 80°04') in June over a mud, silt, and muck bottom with limited vegetation, in less than 8 ft of moderately turbid water (Kenyon, pers. comm. 1979).

New York

Dunkirk Harbor (42°30', 79°20'). Adults in spawning condition were found here in late June (Greeley 1929).

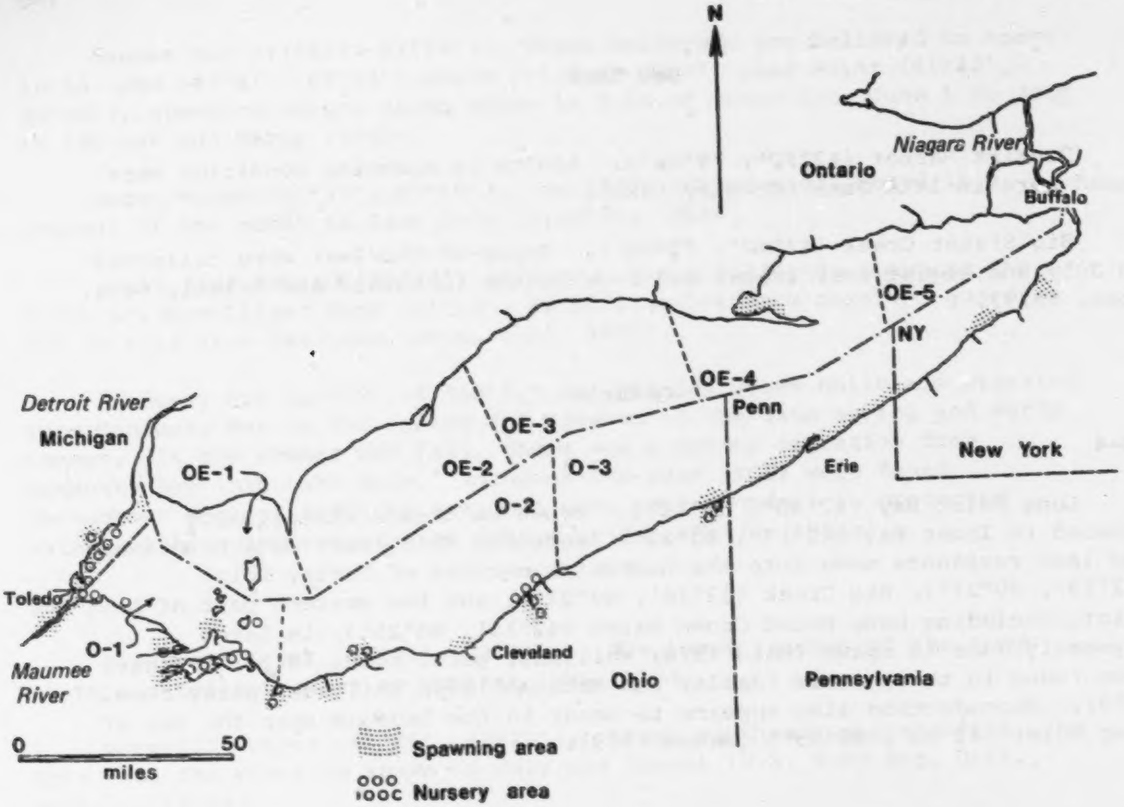
Big Sister Creek (42°40', 79°04'). Young-of-the-year were collected in July and August over gravel and rock bottom (Griswold and Galati, pers. comm. 1979).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Brown bullheads historically spawned in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898). Both bay and lake residents move into the backwater marshes of Turkey Point (42°39', 80°21'), Big Creek (42°36', 80°27'), and the western part of Long Point, including Long Point Crown Marsh (42°35', 80°25'), in late May-early June to spawn (Reid 1978; Whillans, pers. comm. 1979); YOY have been found in these areas (Hamley and MacLean 1979; Whillans, pers. comm. 1979). Reproduction also appears to occur in the lagoons near the tip of Long Point (42°33', 80°05') (Mahon 1979).

CHANNEL CATFISH


N
Ontario
Niagara River
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-1
OE-3
OE-2
O-3
O-2
Erie
New York
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Channel catfish enter Lake Erie tributaries to spawn. Young-of-the-year (YOY) apparently move downstream after hatching and take up residence in bays and nearshore areas of the lake (Barnes 1979); they are widely distributed along the south shore of the lake in up to 15 ft of water (Wolfert, pers. comm. 1979). Channel catfish are fairly abundant in the central basin of Lake Erie. Spawning is highly successful in unpolluted water and on stone breakwalls; they also migrate up many tributaries to spawn (White, pers. comm. 1979). Young-of-the-year are found at many sites in the nearshore waters of the western basin by July (Van Vooren and Davies 1974; Van Vooren, Davies, and Emond 1977).

Michigan

The entire shoreline from Brest Bay (41°55', 83°18') to North Cape (41°44', 83°25') is a spawning and nursery area. Spawning occurs on shallow exposed rock and rubble in May and June (Wolfert, pers. comm. 1979). Young-of-the-year were more abundant near the Woodtick Peninsula (41°44', 83°25') than farther north (MDNR 1970-76). Several spawning sites have been identified:

Pointe Mouillee State Game Area (42°02', 83°12'). Since the 1950s, spawning has occurred in an area (42°02', 83°10') about 1-1/2 mi east of the northern boundary of the game area (Organ et al. 1978).

Pointe Mouillee (42°01', 83°12'). In 1935-68, spawning occurred in an area (41°59', 83°13') south of Pointe Mouille over mud (Organ et al. 1978).

Brest Bay (41°55', 83°18'). Channel catfish spawn in the northern part of the bay over mud (at 41°56', 83°17') (Organ et al. 1978).

Raisin River (41°53', 83°20'). Spawning occurs in the marshy areas at the mouth of the river (Organ et al. 1978). Larvae and YOY are very abundant in the lower discharge canal at the Monroe Power Plant (41°53', 83°21') in May and June and are much more common in the discharge canal and in the Raisin River than in the surrounding lake waters (Cole 1976, 1978b; MacMillan 1976; Nelson 1975; Nelson and Cole 1975; Parkhurst 1971). Based on these collections, spawning and hatching were assumed to occur in the discharge canal (Cole 1976).

La Plaisance Bay (41°52', 83°22'). Spawning occurs in the marshy areas in the north part of the bay (Organ et al. 1978).

Muddy Creek (41°50', 83°25'). Channel catfish spawn in the marshy areas off the creek mouth and also at the dumping ground (41°48', 83°21') about 4 mi offshore (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Spawning occurs, on the lake shore just off the mouth of Whitewood Creek (41°48', 83°26') over vegetation, on the inside of the Peninsula off the Whiting Power Plant (41°47', 83°27'), and around Indian Island (41°45', 83°27') in areas of mud and vegetation (Organ et al. 1978).

Ohio

O-1

Maumee River (41°41', 83°28'). The river is a spawning area (Barnes 1979; Pinsak and Meyer 1976). Channel catfish spawn from May 25 to July 20 in the bay in an area (41°44', 83°27') north of the river mouth and from the river mouth east along shore to Cedar Point (41°42', 83°20') (Pinsak and Meyer 1976). Young-of-the-year were collected throughout Maumee Bay (41°43', 83°25') in late July (USACE 1976c).

Metzger Marsh (41°39', 83°14'). YOY were captured just off the marsh in mid-July (Van Vooren and Davies 1974).

Portage River (41°31', 82°56'). Adults migrate from the deeper waters of the island region into the river to spawn (Reynolds, pers. comm. 1979). Newly hatched fry were collected in Four Mile Creek, a tributary of the Portage River located 15 mi upstream from Lake Erie, in early July (Langlois 1954).

Scott Point (41°35', 82°50'). Spawning occurs on shallow, exposed rock and rubble during May and June (Wolfert, pers. comm. 1979).

Kelleys Island (41°36', 82°42'). In 1951, YOY 2 in. long were collected east of Kelleys Island just above the bottom in 58 ft of water in August. Young appeared to have moved from shallower water to feed in the deeper area (Langlois 1954).

Sandusky Bay (41°29', 82°46'). A major spawning run enters Sandusky Bay and proceeds up the Sandusky River (41°27', 82°59') in the spring (Chapman 1954a, 1955; FWS 1979d; Langlois 1954; Reynolds, pers. comm. 1979). Spawning occurs in May and June in areas with strong current, including the riprap of the Bay Bridge off Martin Point (41°28', 82°50'), the railroad bridge (41°29', 82°49'), and where streams enter the bay (Wolfert, pers. comm. 1979). During 1953-54, a spawning run entered the bay in the spring, and a return migration to the lake occurred in the fall (Chapman 1955). Sandusky Bay is also a nursery area (Wolfert, pers. comm. 1979). Young-of-the-year were found throughout the bay in May-October but were most abundant in protected waters with aquatic vegetation (Chapman 1955; Keller 1964a; Langlois 1954). In 1953, newly hatched larvae were found in Muddy Creek, a tributary of the Sandusky River, on July 15 (Langlois 1954). The young evidently move out of rocky areas onto mud bottom (Wolfert, pers. comm. 1979).

O-2

Huron River (41°24', 82°33'). This is a major spawning area. Channel catfish migrate upstream to a backwater area where they spawn on the stone breakwall, and on sandy, gravelly shallows (White, pers. comm. 1979). Fry were found in the lower river and at the river mouth; these may have originated from spawning that occurred in the river or the lake (Cleveland Environ. Res. Group, undated).

Vermilion River (41°26', 82°22'). Channel catfish migrate into the river to spawn in July and August (U.S. Army Eng. Dist., Buffalo, 1976a).

Lorain Harbor (41°28', 82°11'). Spawning occurs on the breakwalls (Odin 1979), and larvae were found in the harbor (Geo-Marine 1978).

Cleveland Harbor (41°31', 81°42'). A major spawning area exists just inside the west marina (Odin 1979).

Chagrin River (41°41', 81°26'). Major spawning occurs in the lower 3/4 mi of the river, which has numerous islands, deadfall, and crevices. During 1972-74, YOY or fry were collected in the lower river and adjacent shoreline areas of the lake (White et al. 1975; White, pers. comm. 1979). In July, many larvae were found at the mouth and farther upstream; later they were found at the mouth and beach areas of the lake (Environ. Resour. Assoc. 1978).

O-3

Conneaut (41°58', 80°33'). Channel catfish enter the Conneaut River (41°58', 80°33'). In 1977, larvae were collected in the lower river during July and August (Aquat. Ecol. Assoc. 1978c). Spawning also occurs in Cladophora beds and sandy areas along the east breakwall of Conneaut Harbor (41°58', 80°33') (Odin 1979).

Pennsylvania

Channel catfish spawn all along the rocky Pennsylvania shoreline in water less than 42 ft deep. Adults may also migrate into tributaries to spawn (Kenyon, pers. comm. 1979).

New York

Spawning occurs along the New York shore in creeks or near creek mouths in early summer, and young are also found in these areas (Greeley 1929).

Sister Creek (42°40', 79°04'). Spawning females were found on clay banks at the creek mouth in early July (Greeley 1929).

Silver Creek (42°33', 79°10'). A fry about 2 in. long was found at the creek mouth in late August (Greeley 1929).

Dunkirk (42°29', 79°20'). Ripe females were collected in late June near Dunkirk (Greeley 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Channel catfish spawn in the marshy areas of Inner Bay (42°37', 80°22'). Major spawning areas within the Inner Bay are Long Point Marsh (42°35', 80°17'), Little Rice Bay (42°35', 80°21'), Turkey Point Marsh (42°39', 80°21'), and the shallows off Turkey Point (42°39', 80°21') (Kerr and Kerr 1860-1898; Whillans 1977, pers. comm. 1979).

BULLHEAD spp.

Michigan

The following areas are spawning sites for unidentified species of bullheads (Organ et al. 1978):

Swan Creek (41°58', 83°15'). In 1921-46, bullheads spawned over mud at the creek mouth in less than 8 ft of water.

Brest Bay (41°55', 83°18'). Until 1956, bullheads spawned over mud in an area (41°56', 83°17') in northern Brest Bay, from shore to the 16-ft depth contour.

Sterling State Park (41°55', 83°20'). Since 1911, bullheads have spawned along shore over rock and gravel.

Raisin River (41°53', 83°20'). Since 1911, bullheads have spawned at the river mouth over vegetation.

Plum Creek (41°54', 83°23'). Since 1950, bullheads have spawned among aquatic vegetation over mud and sand bottom at the mouth of the creek and along the adjacent shoreline.

Woodchuck Creek (41°51', 83°24')--La Plaisance Creek (41°52', 83°23'). Bullheads spawn here close to shore over gravel substrate.

Otter Creek (41°51', 83°24'). Bullheads spawn over mud in the embayment at the creek mouth (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Spawning occurs in muddy areas 1-8 ft deep, both inside (41°46', 83°27') and on the lake side (41°46', 83°26') of the peninsula.

Indian Island (41°45', 83°27'). Since 1911, bullheads have spawned here over mud and gravel in water 1-2 ft deep.

Ohio

O-1

Sandusky Bay (41°29', 82°46'). Bullheads spawn successfully in the bay in large numbers (FWS 1979d).

O-2

Vermilion River (41°26', 82°22'). Bullheads enter the river to spawn in July and August (U.S. Army Eng., Buffalo Dist. 1976a).

Cleveland Harbor (41°31', 81°42'). A major spawning area exists just inside the west marina (Odin 1979).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Ripe adults were collected in the shallows and lagoons of the north and west shores of the bay, including Thompson Bay (42°10', 80°05') and Horseshoe Pond (42°10', 80°05'); these are probably spawning areas (Larsen, pers. comm. 1979).

STONECAT

In Lake Erie, stonecats spawn from early June to late August; spawning peaks in the last 2 weeks of June (Gilbert 1953). Adults caught in mid-June had large eggs (Scott 1967). Eggs are deposited under stones, submerged boards, and other flat objects. Both parents guard the eggs and young. The incubation period is 2 weeks, and hatching begins in mid-June (Gilbert 1953).

Ohio

O-1

Portage River (41°31', 82°56'). In 1952 and 1953, young-of-the-year (YOY) were collected from the undersides of flat stones on the riffles in late June and July. Spawning occurred on the lowermost riffles. Adults may enter the river from Lake Erie to spawn; YOY may migrate downstream to the lake (Langlois 1954).

South Bass Island (41°39', 82°50'). Stonecats spawn on the bouldery shoals of Put-In-Bay (41°39', 82°49') in early June. Egg masses were found under rocks on these shoals. In 1947, gravid females were collected on Peach Point reef (41°40', 82°50') off northern South Bass Island on June 27 (Langlois 1954).

O-2

Huron River (41°24', 82°33'). Spawning occurs in the lowermost riffles of the river (Langlois 1954).

O-3

Conneaut (41°58', 80°33'). In 1977, larvae were collected near shore just east of Conneaut Harbor during August (Aquat. Ecol. Assoc. 1978c).

Turkey Creek (41°58', 80°32'). In 1977, larvae were collected at the mouth of the creek on July 13 (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

The entire shoreline of Pennsylvania at depths of 42 ft or less is a major spawning area for a resident population of stonecats. During June, gravid females were observed over rock and gravel bottom with no vegetation (Kenyon, pers. comm. 1979).

New York

Sister Creek (42°40', 79°04'). Stonecat egg masses were observed under flat stones in the lower creek on July 13 at a water temperature of 82°F. The eggs were being guarded by adults (Greeley 1929).

TADPOLE MADTOM

Ohio

O-1

Spawning occurs in bays, along shore, and in low gradient streams in the western basin of Lake Erie over muddy bottom (Trautman 1948).

Ontario

OE-4

Long Point (42°33', 80°10'). Reproducing populations are probably established in the lagoons on Long Point (Mahon 1977, 1979). In 1975, ripe females were found here in late May and early August. Spawning probably did not occur until August; no young-of-the-year (YOY) were found in August but they would have been too small to have been collected at that time (Mahon 1977, pers. comm. 1979). In 1977, a few YOY were found in Long Point Crown Marsh (42°35', 80°25') at the base of Long Point (Reid 1978).

BRINDLED MADTOM

Ohio

O-1

Spawning occurs on rocky reefs (Langlois 1954), in bays, along shore, and in low gradient streams over a clean bottom (Trautman 1948).

South Bass Island (41°39', 82°50'). Prior to 1955, egg masses were observed under boulders on the beaches of South Bass Island (Trautman, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10'). Spawning evidently occurs at Long Point; one young-of-the-year was found in Long Point Crown Marsh (42°35', 80°25') (Reid 1978).

FLATHEAD CATFISH

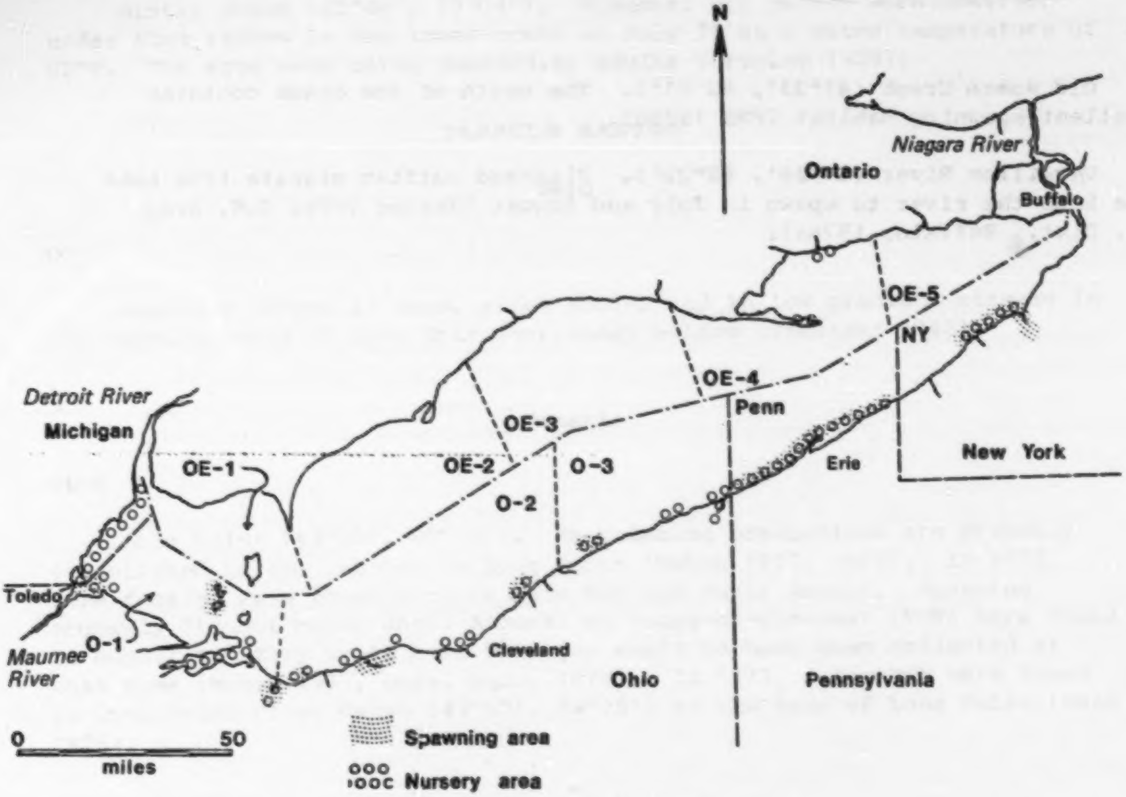
Ohio

O-2

Old Woman Creek (41°23', 82°31'). The mouth of the creek contains excellent spawning habitat (FWS 1979d).

Vermilion River (41°26', 82°22'). Flathead catfish migrate from Lake Erie into the river to spawn in July and August (Teater 1976; U.S. Army Eng. Dist., Buffalo, 1976a).

TROUT-PERCH


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
OE-2
O-3
Erie
New York
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In Lake Erie, trout-perch spawn over pebbly beaches near river mouths (Environ. Resour. Assoc. 1978; White, pers. comm. 1979). Spawning may occur from June to late July (Scott 1967). In northern Ohio, adults are ripe in the latter part of April or early May and spawn usually from late spring to August (Fish 1932; McCormick 1892; White, pers. comm. 1979). In the eastern basin, trout-perch came inshore in large numbers and often ascended creeks from late June to mid-July (Greeley 1929). In western Lake Erie trout-perch spawn over sand and gravel shallows, inshore and in tributary streams. Spawning usually occurs from May to August and peaks in mid- to late June (Fish 1932; Kinney 1950; Langlois 1954; Scott 1967; Trautman 1957). The major hatching period is June 1-15 at approximately 68°F (Comm. Fish. Rev. 1961a). Young-of-the-year were collected in western Lake Erie in June and July (Baker 1966b).

Michigan

Detroit River (42°03', 83°08')--La Plaisance Bay (41°52', 83°22'). In 1966, young were abundant in the area from the mouth of the Detroit

River to La Plaisance Bay (Baker 1967a). Young-of-the-year (YOY) were present in this area, and were most abundant off Sterling State Park (41°55', 83°20') in August 1972 (MDNR 1970-76). In 1975 and 1976, larvae were entrained at the Monroe Power Plant (41°53', 83°21') (Detroit Edison 1976h).

Muddy Creek (41°50', 83°25'). In the late 1970s, larvae were collected off the creek mouth (Wapora 1979b); in 1953, fry were collected here in mid-July (Langlois 1954).

Woodtick Peninsula (41°44', 83°25'). In the late 1970s, larvae were abundant near the Whiting Power Plant (41°47', 83°27') (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). In 1975, ripe or gravid adults were collected in May, and a few YOY were collected in late July (USACE 1976c). From 1960 to 1964, the fry were most abundant in Ohio waters in the southwest corner of the basin near Maumee Bay (Baker 1965).

Bass Islands (41°41', 82°49'). Spawning was observed in quiet water with very little current, primarily near the surface or well above the substrate in about 12 ft of water (Trautman, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). In 1961-63, YOY were abundant in the western part of the bay (Keller 1964a). In 1965, they were also collected in the bay and in nearshore areas east of the bay in June-late July; in 1966, they were present in all parts of the bay in August (Baker 1966b, 1967a).

O-2

Huron River (41°24', 82°33'). Trout-perch enter the river in April, and YOY are found in the river later in the summer (Rawson, pers. comm. 1979).

Erie Power Plant (41°23', 82°30'). In 1974, trout-perch larvae were taken in May-July at the plant; one egg was also collected (Ohio Edison 1977).

Beaver Creek (41°26', 82°15'). Historically, trout-perch were common in the creek; adults with well-developed gonads were collected in the creek in late April (McCormick 1892). In 1979, sampling to the 36-ft depth contour off the mouth of the creek yielded eggs from mid-April to late May, prolarvae from late May to mid-July, and postlarvae from late May to mid-August; juveniles and YOY were also captured there (Commonw. Assoc. 1979).

Black River (41°28', 82°11'). Historically, trout-perch were common in the river; adults with well-developed gonads were collected in the river in late April (McCormick 1892). In 1977, small numbers of larvae were collected in Lorain Harbor (41°28', 82°11') (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1977-78, trout-perch larvae were entrained at the plant and collected in the lake from April to June (Applied Biology 1979c).

Cleveland Harbor (41°31', 81°42'). In 1972-74, small numbers of YOY were collected in the harbor; the harbor may be a spawning area (White et al. 1975). Large numbers of larvae were collected on the beaches both east and west of the harbor (White, pers. comm. 1979). In 1977-78, larvae were entrained at the Lakeshore Power Plant (41°32', 81°38') in May-July; 14% of the larvae entrained throughout the year and 38% of the larvae entrained in the spring were trout-perch (Applied Biology 1979a).

Chagrin River (41°41', 81°26'). Trout-perch spawn near the mouth of the river (Environ. Resour. Assoc. 1978; White, pers. comm. 1979). Gravid and spent adults were found at the river mouth and along the beach; no larvae were found in the river. Peak production of larvae was in mid-May (Environ. Resour. Assoc. 1978). In 1977-78, 15% of the larvae collected near the Eastlake Power Plant from mid-April to late June were trout-perch (Applied Biology 1979b).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, eggs, prolarvae and postlarvae were collected in the vicinity of the plant, indicating that trout-perch spawned in the area. Trout-perch eggs were 40% of the eggs collected in mid-May. Prolarvae were present in May and June (NUS 1975).

Ashtabula (41°55', 80°47'). In 1977-78, larvae were entrained at the Ashtabula power plants (41°55', 80°46') in the spring (Applied Biology 1979e).

Conneaut (41°58', 80°33'). In 1977, trout-perch larvae were collected between Conneaut and Raccoon Creek (41°59', 80°29') in June and July. Larvae were abundant nearshore in mid-June and offshore in mid- and late June. The larvae were most abundant inshore near the hatching grounds. Larvae were collected in the Conneaut River (41°58', 80°33') on May 10 and in Conneaut Harbor (41°58', 80°33') in June (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

The entire offshore area is a major spawning area for a resident population of trout-perch. There may be a slight inshore movement associated with spawning. Spawning occurs inside the 54-ft depth contour over clean mud or gravel-rubble substrates. Gravid females are generally present in June. Fry are present inside the 36-ft depth contour in August and inside the 60-ft depth contour in November (Kenyon, pers. comm. 1979).

New York

Van Buren Bay (42°27', 79°25'). Running ripe adults were found. Trout-perch eggs were found during late April to mid-June and made up 21% of all eggs collected. Prolarvae were found in May-July and postlarvae in June and July, indicating that spawning occurs through June (Envirosphere 1977a; Tex. Instrum. 1977a).

Dunkirk Harbor (42°30', 79°20'). Trout-perch eggs were found throughout the harbor (NMPC 1976, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d) and were entrained at the Dunkirk Steam Station (42°30', 79°21') from April to June (Tex. Instrum. 1977e). Prolarvae were found in the harbor from May to August and postlarvae in June and July (Tex. Instrum. 1977d). Prolarvae were entrained at the Dunkirk Steam Station in late May to mid-July and postlarvae in June to mid-July (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14'). Running ripe adults were found in the bay (Tex. Instrum. 1977a). Trout-perch eggs were found in late April to mid-June and made up 56% of all eggs collected at Eagle Bay (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a). Prolarvae were found from late May to mid-July and postlarvae in June and July, indicating that spawning occurs through June (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). Adults in spawning condition were seen in the creek, and one egg was collected from gravel riffles in early July (Greeley 1929).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Trout-perch are believed to spawn in Long Pond on Long Point (42°33', 80°05') based on the presence of numerous YOY (Mahon and Balon 1977a). In 1974, a few YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in early June and early July (Teleki 1976).

BURBOT

Historical reports indicate that burbot were full of spawn from November to mid-March, and that the hatching period extended from early summer until late June. More recent information indicates that spawning may begin in early fall (Kenyon, pers. comm. 1979) in some areas and extend into early May (White, pers. comm. 1979) in others. In 1928-29, larvae about 0.1-0.6 in. long were commonly collected in water up to about

200 ft deep throughout the central and eastern basins from June to August (Fish 1929, 1930, 1932). Fishermen indicated that spawning occurred in March and no later than April 15. Ripe and spent females were caught during the spawning period in open water 9 mi from shore and 60-66 ft deep. Fishermen reported there were both deep- and shallow-water spawners (Clemens 1951). Burbot historically spawned in open water (Greeley 1929). Burbot presently move to shallow areas to spawn (White et al. 1975).

Michigan

Fermi Power Plant (41°57', 83°15'). Burbot eggs were entrained at the plant in February and March (Detroit Edison 1976g); small numbers of burbot larvae were collected in the vicinity of the plant (Detroit Edison 1978).

Monroe (41°55', 83°24'). In 1975, burbot eggs were entrained at the Monroe Power Plant (41°53', 83°21') in early February (Detroit Edison 1976h).

Ohio

O-1

Portage River (41°31', 82°56'). Historically, burbot probably entered the Portage River to spawn; by 1965 runs no longer occurred (Langlois 1965).

Bass Islands (41°41', 82°49'). Ripe females were collected under the ice in an area between South Bass (41°39', 82°50') and Rattlesnake (41°41', 82°51') islands in January and February (Kinney 1954; Langlois 1954).

O-2

Chagrin River (41°41', 81°26'). Burbot run into water 20-40 ft deep near the river mouth to spawn in May (White, pers. comm. 1979).

O-3

Ashtabula (41°55', 80°47'). Spawning occurs in late April-early May at water temperatures of about 46-50°F in 20-40 ft of water; adults and larvae were collected here (White, pers. comm. 1979). In 1929, moderate numbers of larvae about 0.2-0.5 in. long were found at 42°00', 80°55' and 42°20', 81°05' northwest of Ashtabula (Fish 1930).

Conneaut (41°58', 80°33'). Spawning occurs in late April-early May at water temperatures of about 46-50°F in 20-40 ft of water; adults and larvae were collected here (White, pers. comm. 1979).

Pennsylvania

Northwest Sand Bar (42°19', 80°20'). Burbot spawn in late fall on this sand bar, which is about 18 mi offshore, and is bounded approximately by latitudes 42°10' and 42°20' and longitudes 80°15' and 80°20'; water depth on the sand bar averages 60 ft (Kenyon, pers. comm. 1979). In 1928, fairly high concentrations of burbot larvae about 0.2-0.5 in. long were found in an area extending northward past the west side of the sand bar toward the base of Long Point (42°32', 80°25') and then westward to the mouth of Clear Creek, Ontario (42°34', 80°35') (Fish 1930).

McCord's Point (42°14', 79°52'). The Pennsylvania Fish Commission classifies this area as a minor burbot spawning area, based on the collection of one gravid female here in the fall. The bottom is broken shale and rock, the water depth is about 36 ft, and the current is onshore and moderate to light. It is assumed that burbot spawn on rocks along the shore (Kenyon, pers. comm. 1979).

Eighteen Mile Creek (42°15', 79°48'). Fair numbers of larvae about 0.2-0.5 in. long were found off the creek mouth at 42°20', 79°50' (Fish 1930).

New York

Westfield (42°19', 79°35'). Fair numbers of larvae about 0.2-0.5 in. long were found near shore in an area (42°22', 79°32') east of Westfield (Fish 1930).

Van Buren Bay (42°27', 79°25'). A few eggs were collected here in late April and early May. Prolarvae were found in late April-June (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). Larvae, including prolarvae, were entrained at the Dunkirk Steam Station (42°30', 79°21') and were present in Dunkirk Harbor in May and June (Tex. Instrum. 1977d,e).

Eagle Bay (42°32', 79°14'). In 1975, a few eggs were collected in April and early May. Prolarvae were collected in May and a few postlarvae were taken in June (Envirosphere 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). In 1929, fair numbers of larvae about 0.2-0.5 in. long were collected off the creek mouth (Fish 1930).

Eighteenmile Creek (42°43', 78°58'). In 1929, fair numbers of larvae about 0.2-0.5 in. long were found near the mouth of the creek (Fish 1932).

Seneca Shoal (42°47', 78°55'). In 1929, fair numbers of larvae about 0.2-0.5 in. long were found near the shoal (Fish 1932).

Ontario

OE-2

Pointe aux Pins (42°15', 81°52'). In 1929, moderate numbers of larvae about 0.2-0.5 in. long were collected at a location (42°10', 81°55') about 4 mi S of the point and at a location (42°00', 82°00') about 20 mi SW of the point (Fish 1930).

OE-3

Port Stanley (42°39', 81°13'). In 1947, running-ripe males and spent females were found 9 mi off Port Stanley to depths of 60-66 ft during mid-March to early April (Clemens 1951). In 1929, moderate numbers of larvae about 0.2-0.5 in. long were found at 42°30', 81°10', about 12 mi S of Port Stanley (Fish 1930).

OE-4

Clear Creek (42°34', 80°35'). In 1928, fairly high concentrations of larvae about 0.2-0.5 in. long were found from Clear Creek east toward the base of Long Point (42°32', 80°25') and then south to the Northwest Sand Bar (42°19', 80°20') (Fish 1930).

Long Point Bay (42°40', 80°10'). In 1928, the largest concentration of burbot larvae occurred in the 105-115 ft deep hole (at approximately 42°31', 79°58') off the tip of Long Point. Larvae were also found off Port Ryerse (42°45', 80°15') and Port Dover (42°47', 80°12') at depths of 99-132 ft (Fish 1932). In 1947, spent females were found off Port Dover in late March to mid-April (Clemens 1951).

OE-5

Low Point (42°50', 79°40'). Fair numbers of larvae about 0.2-0.5 in. long were found offshore in an area (42°35', 79°40') about 17 mi S of Low Point (Fish 1930).

Point Abino (42°50', 79°06'). In 1929, fair numbers of larvae about 0.2-0.5 in. long were found off the point (Fish 1932).

BANDED KILLIFISH

The banded killifish spawns in localized areas of Lake Erie in June (Fish 1932), usually in sheltered locations, including bays and creek mouths (Greeley 1929).

Ohio

O-3

Ashtabula (41°55', 80°47'). The banded killifish spawns on a sand bar at the mouth of Ashtabula Harbor (White, pers. comm. 1979).

Ontario

OE-4

Long Point (42°33', 80°10'). Reproducing populations are probably established in some of the lagoons on Long Point. Young-of-the-year (YOY) were numerous in one of the lagoons (Mahon 1979; Mahon and Balon 1979a), and a few were found in Long Point Crown Marsh (42°35', 80°25') at the base of the point (Reid 1978).

OE-5

Crescent Beach (possibly Crescent Park, 42°53', 78°58'). In 1929, YOY were found here in 3 ft of water at Crescent Beach in late June (Fish 1932).

BROOK SILVERSIDE

Michigan

Swan Creek (41°58', 83°15'). In 1975, larvae were collected in small numbers along the beach in an area (41°59', 83°14') just north of the creek in mid- to late June (Waybrant and Shauver 1979).

Ohio

O-1

West Harbor (41°34', 82°49'). In 1919, fry were collected along a flat, sandy beach with no vegetation (Turner 1920a).

Starve Island (41°38', 82°49'). A few fry were collected around the shores of the island, which had precipitous, jagged limestone walls and rock masses and no vegetation. Ballast Island (41°41', 82°47'). Fry were found along the southwest shore over a steep gravel and rubble beach with little vegetation. South Bass Island (41°39', 82°50'). Fry were collected along beaches on the southern shore of Squaw Harbor (41°39', 82°49') in 1-4 ft of water over fine sand, mud, and gravel with spike rushes and other vegetation; they were exceedingly abundant in an area (41°39', 82°47') on the northeast shore on a rock and gravel beach with no vegetation. Middle Bass Island (41°41', 82°49'). Fry were found on the north shore (at 41°42', 82°48') and on the west point (at 41°41', 82°50') along shallow gravel and stone beaches with a few boulders, and submergent vegetation within 4 ft of shore (Turner 1920a).

Sandusky Bay (41°29', 82°46'). In 1961, a few young-of-the-year (YOY) were collected in the western part of the bay from May to October (Keller 1964a).

O-2

Lorain Harbor (41°28', 82°11'). In 1977, a few larvae were collected in the harbor (Geo-Marine 1978).

Chagrin River (41°41', 81°26') and Cleveland Harbor (41°31', 81°42'). In 1972-74, fry or YOY were collected in these areas which may be spawning areas (White et al. 1975).

O-3

Conneaut Harbor (41°58', 80°33'). In 1977, fry were collected at the surface in mid-August (Aquat. Ecol. Assoc. 1977).

Ontario

OE-1

Holiday Beach (42°01', 83°02'). In 1975, large numbers of YOY were collected with seines here in July (Paine 1976).

Colchester (41°59', 82°56') and Cedar Beach (42°01', 82°47'). In 1975, YOY were collected along the beach in July (Paine 1976).

OE-4

Long Point (42°33', 80°10'). Reproducing populations are probably established in the larger lagoons of Long Point (Mahon 1979). A few YOY were found in Long Point Crown Marsh (42°35', 80°25') at the base of the point, where spawning was believed to occur in mid-late April (Reid 1978).

BROOK STICKLEBACK

Ohio

O-2

Rocky River (41°30', 81°50'). The river may be a spawning area; young-of-the-year were collected here (White et al. 1975).

WHITE PERCH

The first reported capture of white perch in Lake Erie occurred in 1953 near Erie, Pennsylvania. How this species entered Lake Erie is unknown (Larsen, pers. comm. 1981).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1976, prolarvae were collected in small numbers near the plant in early July (Detroit Edison 1978).

Monroe (41°55', 83°24'). An area (at 41°52', 83°20') off Plum Creek (41°54', 83°23') is a nursery ground for young-of-the-year (YOY) white perch; they are found here from about mid-May to October over sand, clay, and gravel, at a water depth of about 10 ft (Rawson, pers. comm. 1979).

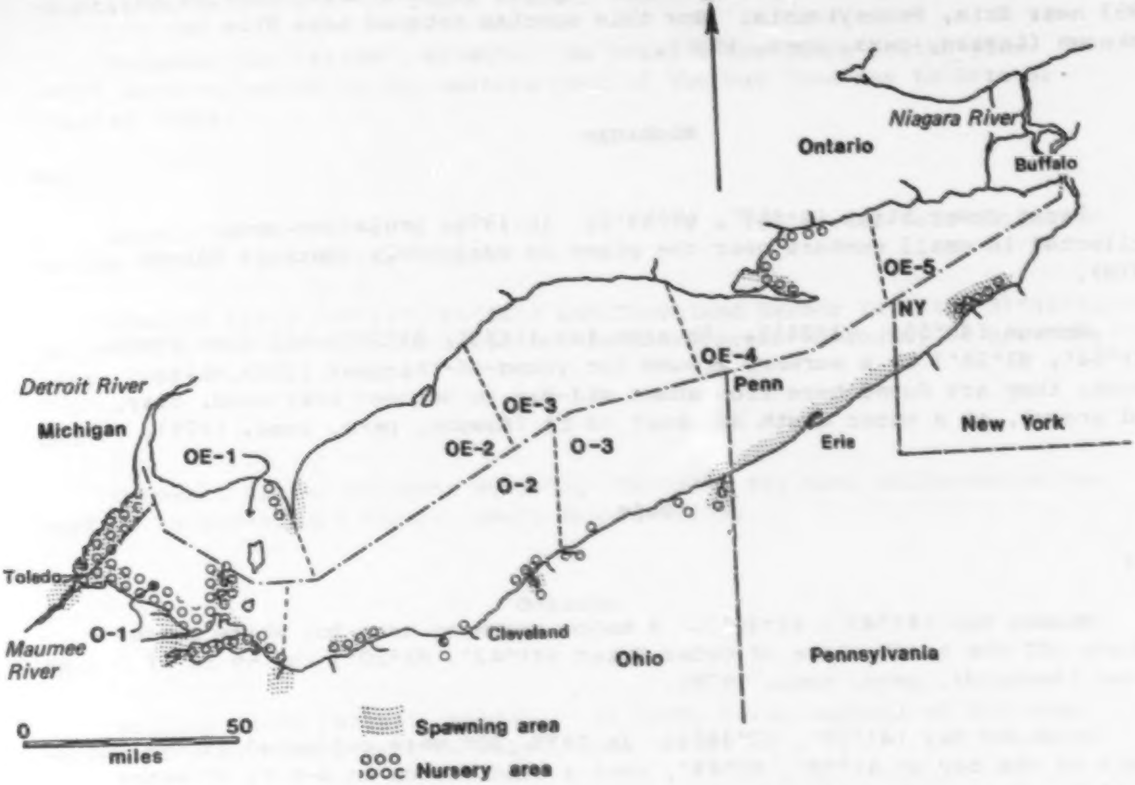
Ohio

O-1

Maumee Bay (41°43', 83°25'). A major spawning area for white perch exists off the north shore of Cedar Point (41°42', 83°20') in 1-6 ft of water (Reynolds, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). In 1978, YOY were collected at the mouth of the bay at 41°29', 82°43', over a sand bottom in 4-6 ft of water (Wolfert, pers. comm. 1979).

WHITE BASS


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
OE-3
Detroit River
Michigan
OE-1
OE-2
O-3
O-2
New York
Erie
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In the western basin of Lake Erie, white bass migrate into the tributaries along the south shore, and proceed upstream as far as the first riffle, to spawn in late April and May (Rawson, pers. comm. 1979). White bass also spawn on rocky reefs and shoals and along shore where there is a current in 10-20 ft of water (FWS 1979d; Riggs 1952; Van Vooren and Davies 1974; Wolfert, pers. comm. 1979). Peak spawning occurs at a water temperature of approximately 55°F (Wolfert, pers. comm. 1979). In 1960, most hatching occurred during July 1-15 at an average water temperature of 75°F (Comm. Fish. Rev. 1961a). In 1929, white bass larvae were abundant in the western part of the lake (Fish 1932). Larvae are most abundant in bays. They are probably carried downstream from the rivers, which are the primary spawning areas, into the bays, which serve as nursery grounds (Heniken 1977; Reutter et al. 1978). Young-of-the-year (YOY) first appear in June (Baker 1966b; Baker and Scholl 1971c; Barnes and Reutter 1979; Van Vooren and Davies 1974; Van Vooren et al. 1974).

In the 1960s and 1970s, YOY were often more abundant in the central basin than in the western basin (Anderson 1966; Baker 1966c; Baker and Bower 1964, 1965; Baker and Scholl 1970, 1972; Parker 1964; Rudolph and Scholl 1969; Seward 1967, 1968; Van Vooren and Davies 1974; Van Vooren et al. 1977). White bass probably enter all of the rivers of the central basin to spawn (USBCF 1966; USDI 1967; White, pers. comm. 1979). No larvae less than about 0.5 in. long were found in the rivers; larvae 0.5-1.0 in. long are present in the lake, on the beaches, and in the harbors (White, pers. comm. 1979). Spawning may also occur in the open lake (Applegate and Van Meter 1970; USBCF 1966; USDI 1967). Tagging studies conducted along the Ohio shoreline have shown that adults migrate out into the lake after spawning in shallow water; some of these adults enter Canadian waters (Greeley 1955).

Michigan

Since 1925, spawning has occurred over rock substrate all along shore from Swan Creek (41°58', 83°15') south to Turtle Island (41°45', 83°23') at depths of about 12-18 ft (Organ et al. 1978). Areas reported to support spawning are:

Swan Creek (41°58', 83°15'). White bass are reported to spawn over mud just off the creek mouth and south to Point aux Peaux (41°57', 83°15'). In 1935-68, spawning also occurred in an area (41°58', 83°10') about 4 mi off the creek mouth over rock and clay in 9-12 ft of water (Organ et al. 1978). In 1976, prolarvae were collected near the Fermi Power Plant (41°57', 83°15') in late May and early June.

Brest Bay (41°55', 83°18')--Raisin River (41°53', 83°20'). White bass spawn in this area to a depth of about 18 ft (Organ et al. 1978); spawning may also occur on the rip-rap in the discharge canal of the Monroe Power Plant (41°53', 83°21') (Cole 1976, 1978b; Parkhurst 1971). Adults are located offshore prior to spawning; they enter the discharge canal on spawning runs. Ripe and spent fish have been collected in the canal (Cole 1976; Lavis 1976; MacMillan 1976; Nelson 1975; Nelson and Cole 1975). White bass larvae are one of the most common larvae in the area; large numbers of white bass larvae were collected in the vicinity of the plant and entrained at the plant from mid-May to late July or August (Cole 1976; Detroit Edison 1976h; MacMillan 1976; Nelson 1975; Nelson and Cole 1975). Larvae are abundant in the discharge canal; they tend to appear in the discharge before they appear at the plant intake (Cole 1976, 1978b).

An area off Monroe (at approximately 41°52', 83°20') in 6-10 ft of water with bottom of sand, hard clay, and gravel, is a nursery area (Rawson, pers. comm. 1979). In most years YOY white bass are most abundant in the Michigan waters of Lake Erie off Monroe (MDNR 1970-76). In 1970, moderately large numbers of YOY were collected near Monroe. After July 22, 95% of the white bass collected were YOY; they were most abundant off Sterling State Park (41°55', 83°20') over a muck and sand bottom in 6-10 ft of water (Parkhurst 1971). Abundance of YOY near Monroe, however, is low relative to that observed in June-September in other areas, such as Sandusky Bay (41°29', 82°46') and Catawba Island (41°35', 82°51') (Baker 1967a, 1967c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970; Van Vooren et al. 1977). The Monroe area could be a very important nursery area for young white bass because dense concentrations of larvae enter this area from the Detroit River (42°03', 83°08') (Cole 1978b; MacMillan 1976).

La Plaisance Bay (41°52', 83°22'). White bass spawn along the shore from La Plaisance Bay to the Woodtick Peninsula (41°44', 83°25') out to about the 18 ft contour over rock and gravel (Organ et al. 1978).

Woodtick Peninsula (41°44', 83°25'). Since the 1920s, spawning has occurred along the entire shore of the peninsula over gravel and rock to depths of about 15 ft; since 1911, spawning has also occurred around Turtle Island (41°45', 83°23') and over sand and mud west of North Cape, on the Michigan-Ohio border (at 41°44', 83°26') (Organ et al. 1978). In 1975, white bass larvae were most abundant in the southern portion of the Michigan waters of the lake. Highest abundance was found in 6-12 ft of water off the Woodtick Peninsula, at 41°47', 83°26' and 41°46', 83°25' (Waybrant and Shauver 1979). In 1978, larvae were entrained at the Whiting Power Plant (41°47', 83°27') and collected from North Maumee Bay; peak abundance occurred in June (Wapora 1976b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Spawning migrations of white bass enter the bay and the Maumee River (41°41', 83°28'). Downstream migrations of larvae occur as the yolk sac is being absorbed (CLEAR 1977; Fraleigh and Tramer 1974; Herdendorf and Cooper 1976; Ohio DNR 1976; Pinsak and Meyer 1976; Rawson, pers. comm. 1979; Reutter, Herdendorf and Sturm 1978a,b; Scholl 1977; Synder 1978; Wapora 1977b,c). In 1980, running-ripe adults were caught during the spawning run on the Perrysburg riffles on May 16 at a water temperature of 66°F (Goodyear, pers. comm. 1980). From July to December, large numbers of YOY are impinged at the Acme Power Station, 4 mi upstream from the river mouth; adults are also impinged when they migrate upstream to spawn (Reutter, Herdendorf and Sturm 1978a). The shallows around the island area in the upper Maumee River estuary, about 15 mi upstream from the lake, are important white bass spawning grounds; more spawning occurs here than in the riffle area farther upstream (Reutter, Herdendorf and Sturm 1978b; Herdendorf and Cooper 1976). Spawning was observed in the river above the bridge at Maumee in 18 in. of water over rock bottom (Langlois 1954). Maumee Bay may be a major spawning area (Cole 1978a), but there is disagreement on this subject (U.S. Army Eng. Dist., Detroit, 1976). Spawning is believed to occur on both sides of the shipping channel (from 41°43', 83°26' to 41°45', 83°23') and in the southern portion of the bay over a sandy, gravel substrate (41°43', 83°24') from May 12 to June 25 (Pinsak and Meyer 1976). The shoal off Cedar Point (41°42', 83°20') is a major spawning area; it has a sand bottom and water 1-6 ft deep (Reynolds, pers. comm. 1979). In 1966-72, YOY were abundant here from June to September (Baker 1967c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970). Maumee Bay is an important nursery area for prolarvae. Larvae prefer quiet bottom areas of the bay with slow current and depths greater than 6 ft (Snyder 1978). In 1975-77, YOY were abundant in the bay from April to July; these fish were believed to have originated from spawning that occurred in the Maumee River (Herdendorf 1977; Herdendorf and Cooper 1975, 1976). In 1976, larvae were found in the bay from April 27 to June 8, and were most abundant in the mid- and lower reaches of the river during the first week in June (Reutter, Herdendorf and Sturm 1978a,b). In 1975 and 1977, larvae were most abundant at the mouth of the bay in late May to mid-June (Herdendorf et al. 1976; Patterson 1979a). The bay is an overwintering area for YOY (FWS 1979d).

Ward Canal (41°39', 83°14'). Large numbers of YOY were found here, especially in July and August (Ayers et al. 1970; Van Vooren et al. 1977, 1978).

Crane Creek (41°38', 83°12'). In 1966-68, YOY were collected at Crane Creek from June to August (Baker 1967a,c, 1969).

Locust Point (41°36', 83°05'). Young-of-the-year are abundant from June to September (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Reutter and Herdendorf 1975, 1977; Rudolph and Scholl 1970; USAEC 1973; USNRC 1975a,b).

Toussaint River (41°35', 83°04') and Portage River (41°31', 82°56'). A spawning run enters the river (Rawson, pers. comm. 1979).

Catawba Island (41°35', 82°51'). In 1966-72, YOY were collected in an area (41°34', 82°53') west of Catawba Island from July to September (Baker 1967a,c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1970; Rudolph and Scholl 1970).

West Harbor (41°34', 82°49'). In 1919, fry were collected in July on a flat sandy beach with no aquatic vegetation (Turner 1920a).

East Harbor (41°32', 82°47'). Large numbers of YOY were found inside and outside the harbor from June to September (Baker 1967a,c, 1969; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolph and Scholl 1970; Van Vooren et al. 1977, 1978).

Bass Islands (41°41', 82°49'). Spawning generally occurred around the islands in 1-5 ft of water over rocky, gravelly bottom (Trautman, pers. comm. 1979).

> South Bass Island (41°39', 82°50'). In 1919, fry were collected at two sites along the eastern shore in July; one site (41°39', 82°49') had a steep sloping rubble beach with no vegetation except filamentous algae, and the other site (41°39', 82°48') was a shallow, sandy gravel beach with some submerged vegetation (Turner 1920a). Spawning occurs off Peach Orchard Point over bedrock limestone, large boulders, big rock, and aggregate gravel, from shore out to the 10 ft contour (MacLean, pers. comm. 1979).

Middle Bass Island (41°41', 82°49'). In 1919, fry were collected in July on the north shore (41°42', 82°48') on a shallow gravel beach with a few boulders and some submergent vegetation. Lost Island (41°41', 82°47'). Fry were collected in July on a steep gravel beach with some pond weed. Ballast Island (41°41', 82°47'). Fry were collected in July over steep, gravel and rubble bottom with aquatic vegetation (Turner 1920a).

West Reef (West Island Shoal, 41°43', 82°51'). In 1973 and 1974, adults were collected from spawning concentrations on West Reef (Van Vooren and Davies 1974; Van Vooren et al. 1975).

Sandusky Bay (41°29', 82°46'). White bass migrate into Sandusky Bay in the spring; catches increase in mid-April, and spawning occurs in April-June. A return migration to Lake Erie occurs in the fall (CLEAR 1977; Cleveland Environ. Res. Group, undated; Chapman 1954a, 1955; FWS 1979d; Lake Erie Fish. Res. Unit Staff 1977; Langlois 1954; Rawson, pers. comm. 1979; Riggs 1952, 1955; Snyder 1978; Van Vooren and Davies 1974; Van Vooren et al. 1975). A resident population is also reported in the Sandusky River (41°27', 82°59') throughout the late spring and summer; the population undergoes considerable fluctuation during the spawning period (Griswold et al. 1978). In the mid-1800s, tremendous numbers of white bass migrated into the Sandusky River; they filled the whole channel in the spring (Keeler 1904). Prior to 1916, large schools migrated up the Sandusky River as far as Fremont to spawn; in 1926, white bass were rarely found at Fremont (Van Oosten 1926). Spawning is also reported to occur in Sandusky Bay (FWS 1979d). Young-of-the-year were abundant throughout the bay beginning in May (Baker 1966b; Baker and Scholl 1971c; Ball and Scholl 1973; Chapman 1955; Gehres and Scholl 1969; Hair and Scholl 1971; Hartley 1975; Hartley and Herdendorf 1975; Keller 1964a; Rudolph and Scholl 1970; Van Vooren and Davies 1974; Van Vooren et al. 1977). In 1976, YOY were collected off the mouth of Sandusky Bay at Cedar Point (41°29', 82°41') in late July (Van Vooren et al. 1977).

O-2

Huron River (41°24', 82°33'). A spawning run enters the river and proceeds upstream to the first riffle area in late April and May (Cleveland Environ. Res. Group, undated; FWS 1979d; Rawson, pers. comm. 1979).

Beaver Creek (41°26', 82°15'). In 1979, eggs were collected in an area (approximately 41°28', 82°15') off the creek mouth at the 36 ft contour on July 5. Prolarvae were found throughout the area from June 12 to August 22; postlarvae were collected from July 12 to August 22 (Commonw. Assoc. 1979).

Lorain Harbor (41°28', 82°11'). Numerous adults were collected in the harbor in early summer; a few larvae were later found in the harbor (Geo-Marine 1978). White bass attempt to run up French Creek, a harbor tributary, but are unsuccessful due to low water quality in the creek (Odin 1979).

Rocky River (41°30', 81°50') and Cleveland Harbor (41°31', 81°42'). In 1972-74, YOY were collected in the harbor and the river (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, YOY were collected in the lower river and along the adjacent lake shore (White et al. 1975). Prolarvae were collected at the Eastlake Generating Station (41°40', 81°27') near the river in June at a water temperature of 65°F. Spawning is believed to occur near the plant or in the mouth of the river (Aquat. Ecol. Assoc. 1976b).

O-3

Grand River (41°46', 81°17'). Young-of-the-year were collected in the river in July (White, pers. comm. 1979).

Perry Power Plant (41°48', 81°09'). In 1974, a few early larvae were collected near the plant on July 12 at a water temperature of 68°F (NUS 1975).

Ashtabula River (41°55', 80°47'). Large numbers of young are present in the river (Odin 1979); YOY were collected at the mouth of the river in July (White, pers. comm. 1979).

Conneaut (41°58', 80°33'). The western corner of Conneaut Harbor (41°58', 80°33') is a spawning area; the substrate is sand and gravel with emergent vegetation (Odin 1979). In 1977, white bass larvae and YOY were collected in the Conneaut River (41°58', 80°33') during the fall, indicating that successful spawning occurred in the river (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

White bass spawn along the Pennsylvania shoreline, including Presque Isle Bay (42°08', 80°07'). Spawning occurs in June over rock, rubble, and sand-clay bottom in water shallower than 42 ft (Kenyon, pers. comm. 1979).

New York

In the late 1920s, YOY were fairly common in creek mouths and at unidentified locations along shore (Greeley 1929).

Van Buren Bay (42°27', 79°25'). In 1975, a few eggs were collected on June 9. A few yolk-sac larvae were found in June to mid-July, postlarvae in June and July, and YOY in August and September (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). Eggs were found throughout Dunkirk Harbor (Niagara Mohawk Power 1976, as cited in Tex. Instrum. 1978). In 1976, eggs were present in June, prolarvae in June and July, and postlarvae in July (Tex. Instrum. 1979d). Prolarvae were entrained on June 14-21 and postlarvae on June 21 and from July 12 to August 3 at the Dunkirk Steam Station (42°30', 79°21') (Tex. Instrum. 1979e).

Eagle Bay (42°32', 79°14'). In 1975, off Eagle Bay, prolarvae were collected from mid-May to late July and postlarvae from mid-June to early August (Envirosphere 1977a; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a); YOY were present near Eagle Bay in August-October (U.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). In the late 1920s, adults were collected along shore in the spring (Greeley 1929).

Ontario

OE-1, OE-2

Point Pelee (41°55', 82°30'). The shoals along the entire shoreline of the point are important spawning areas (Environ. Can. 1977a). Young-of-the-year were collected on the northwest beach on the point (Paine 1976).

OE-4

Long Point Bay (42°40', 80°10'). In 1888, white bass were observed spawning at Turkey Point (42°39', 80°21') in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898; Whillans 1977). Fishermen catch gravid adults entering Doctors Inlet (42°34', 80°16') in the spring (Whillans, pers. comm. 1979). White bass larvae were seined inshore near the Nanticoke Generating Station (42°48', 80°03'); they appear to favor the littoral areas during August (Kelso 1972; Teleki 1975a). In 1974, YOY were entrained at the Nanticoke Station in June-August (Teleki 1976). Long Point Bay is a nursery ground for white bass (Teleki 1975b).

ROCK BASS

Michigan

Sterling State Park (41°55', 83°20'). Since 1921, spawning has occurred along the entire shoreline of the park out to the 6 ft depth contour over rock and mud (Organ et al. 1978).

Ohio

O-1

Rock bass build nests on shallow sand and gravel shoals around the islands in the western basin, in protected bays and harbors, and in the lower reaches of south shore tributaries. The dates of spawning depend on water temperatures; in the islands area, spawning generally occurs from mid-June to July (Langlois 1954; Trautman, pers. comm. 1979).

West Harbor (41°34', 82°49'). In 1919, fry were collected on a flat sand beach at the mouth of the harbor (Turner 1920a).

South Bass Island (41°39', 82°50'). In 1919, fry were collected during July over a stone bar off Peach Point (41°40', 82°50'), and over mud in Terwilliger Pond (41°39', 82°50'); they were most abundant on a stone bar off the southwest end of Gibraltar Island (41°39', 82°49') (Turner 1920a). In 1958, fry were collected in Put-in-Bay (41°39', 82°49') in early July (Davis 1959). Ripe adults were collected during June and July off the west side of Gibraltar Island, and spawning was observed under the docks in water 2-3 ft deep at a water temperature of about 72°F (Ernest 1960). Nesting has also been observed on Alligator Bar (41°39', 82°49') between Gibraltar Island and Oak Point (41°39', 82°49') (Trautman, pers. comm. 1979).

Middle Bass Island (41°41', 82°49'). In 1919, fry were collected from the large bay on the north shore (41°42', 82°48') along a gravel beach with submergent vegetation (Turner 1920a).

North Bass Island (41°43', 82°49'). Fry were collected over fine sand along the southern shore (41°42', 82°49') and on a rubble beach on the southwest point (41°43', 82°50') (Turner 1920a).

Sandusky Bay (41°29', 82°46'). This is a minor spawning area for rock bass (FWS 1977d).

O-2

Rocky River (41°30', 81°50'), Cleveland Harbor (41°31', 81°42'), and Chagrin River (41°41', 81°26'). In 1972-74, fry or young-of-the-year (YOY) rock bass were collected in the harbor and in the lower rivers; these may be spawning areas (White et al. 1975).

O-3

Fairport (41°46', 81°17') and Ashtabula (41°55, 80°47'). Adults spawn on the harbor breakwalls at these locations (White, pers. comm. 1979).

Conneaut (41°58', 80°33'). A large number of ripe adults was collected in Conneaut Harbor (41°58', 80°33'), spawning was observed on the breakwall, and YOY were later collected in the vegetated shallows of the harbor in 5-10 ft of water. In 1977, larvae were collected from the harbor and from the Conneaut River (41°58', 80°33') during June and July (Aquat. Ecol. Assoc. 1978c).

New York

Chautauqua Creek (42°20', 79°36'). Young-of-the-year were collected in the fall in the lower creek over gravel and rock in 2-4 ft of water; this is assumed to a spawning and nursery area (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Postlarvae were found in July in waters off Eagle Bay (Tex. Instrum. 1977a).

Canadaway Creek (42°28', 79°22'). Young-of-the-year were collected in the fall in the lower creek over gravel and rock in 2-4 ft of water; this is assumed to be a spawning and nursery area (Griswold and Galati, pers. comm. 1979).

Eagle Bay (42°32', 79°14'). Postlarvae have been found in waters off Eagle Bay in July (Tex. Instrum. 1977a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Inner Bay (42°37', 80°22') is a nesting area for rock bass; spawning occurs in late May to early June throughout the marshy shoreline areas (MacLean and Teleki 1977; Reid 1978; Whillans 1977, pers. comm. 1979). In the spring, rock bass migrate westward about 22-25 mi along the north shore of Long Point Bay to spawning grounds in Inner Bay. There is a return migration after spawning. Most of the movement occurs in 12 ft or less of water within 1 to 1-1/2 mi of shore (Chamberlain 1976a; Hamley 1979; Hamley and MacLean 1979; MacLean and Teleki 1977; Teleki et al. 1977). Young-of-the-year rock bass were captured along the north shore of Lake Erie, only at shoreline seining sites in or near Inner Bay (Hamley and MacLean 1979; MacLean and Teleki 1977; Reid 1978). Reproducing populations of rock bass are also probably established in the lagoons at the end of Long Point (42°33', 80°05') (Mahon 1979).

GREEN SUNFISH

Ohio

O-1

South Bass Island (41°39', 82°50'). In 1919, fry were collected in Terwilliger Pond (41°39', 82°50') off Put-In-Bay. The pond was 1-7 ft deep, with a mud bottom and aquatic vegetation (Turner 1920a).

O-2

Cleveland (41°30', 81°43'). Green sunfish have been observed on nests in the old channel of the Cuyahoga River (41°30', 81°43'). During 1972-74, small numbers of fry or YOY were collected in Cleveland Harbor (41°31', 81°42') and also in the lower Rocky River (41°30', 81°50') and along the adjacent lake shore, which may also be spawning areas (White et al. 1975; White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). In 1972-74, a few larvae and young-of-the-year (YOY) were collected in the lower river; spawning probably occurs on the rock breakwaters (Environ. Resour. Assoc. 1978; White et al. 1975).

PUMPKINSEED

Ohio

Pumpkinseeds spawn in all of the harbors along the Ohio shoreline (White, pers. comm. 1979).

O-1

Sandusky Bay (41°29', 82°46'). Sandusky Bay is a minor spawning area for pumpkinseeds (FWS 1979d). In 1915, pumpkinseeds were observed on nests in Beimiller's Cove (41°28', 82°40') on Cedar Point in July. Nests as large as 36 x 27 in. guarded by large adults were located 10-20 ft from shore on sandy stretches of bottom at depths of 11-15 in. Nests as large as 7 x 7 in. guarded by small adults were located within 6 ft of shore on pebble bottom, among reeds in water less than 7 in. deep. All nests occurred in groups (Krecker 1916).

O-2

Cleveland (41°30', 81°43'). In 1972-74, adults were observed tending nests in Cleveland Harbor (41°31', 81°42'), and young-of-the-year were abundant in the harbor. Young-of-the-year were also collected in the lower Rocky River (41°30', 81°50') and adjacent shorelines; these may be spawning areas (White, pers. comm. 1979; White et al. 1975).

Chagrin River (41°41', 81°26'). In 1975, a few prolarvae were collected in June at the Eastlake Power Plant (41°40', 81°27'), suggesting that spawning takes place in the immediate plant area or in the mouth of the river (Aquat. Ecol. Assoc. 1976b).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Historically, pumpkinseeds spawned in the marshy shoreline areas of Inner Bay (42°37', 80°22') (Whillans

1977, pers. comm. 1979). Spawning is believed to occur in mid-June in Long Point Crown Marsh (42°35', 80°25') at the base of Long Point, where many YOY were found through August (Reid 1978). Reproducing populations are also established in the lagoons at the end of Long Point (42°33', 80°05') (Mahon 1979, pers. comm. 1979).

ORANGESPOTTED SUNFISH

Ohio

O-2

Chagrin River (41°41', 81°26'). In 1972-74, young-of-the-year were collected in the lower river and adjacent shoreline areas of the lake (White et al. 1975). Spawning may occur on the rocky breakwaters (Environ. Resour. Assoc. 1978).

BLUEGILL

Michigan

Bay Creek (41°47', 83°27'). Bluegills spawn near the mouth of Bay Creek in shallow water (Organ et al. 1978).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). The bay is a spawning area for bluegills (FWS 1979d). In 1953-54, bluegills spawned in the bay throughout the summer, and young-of-the-year (YOY) were widely distributed throughout the bay (Chapman 1955). In 1961-63, YOY approximately 1 in. long were taken in the western end of the bay in May to October (Keller 1964a).

O-2

Cleveland (41°30', 81°43'). In 1972-74, YOY or fry were collected in the Rocky River (41°30', 81°50') and Cleveland Harbor (41°31', 81°42'); these are probably spawning areas (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1972-74, YOY or fry were collected in the lower river and adjacent shores (White et al. 1975). Spawning probably occurs on the rocky breakwaters, and the spawners could be river residents (Environ. Resour. Assoc. 1978).

New York

Van Buren Bay (42°27', 79°25'). Postlarvae were found in July in waters off the bay (Tex. Instrum. 1977a).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). The weedy coves in the harbor are excellent habitat for bluegills, and considerable spawning was seen in these areas (Berst 1950).

OE-4

Long Point Bay (42°40', 80°10'). Historically, bluegills spawned in the marshy areas of Inner Bay (42°37', 80°22') (Whillans 1977, pers. comm. 1979). A few YOY were found in Long Point Crown Marsh (42°35', 80°25') at the base of Long Point (Reid 1978). Reproducing populations are also established in the lagoons on Long Point (42°33', 80°10'), where ripe females were found in May (Mahon 1979, pers. comm. 1979; Mahon and Balon 1977b).

SUNFISH spp.

Michigan

Brest Bay (41°55', 83°18'). In 1977, early postlarvae were collected in early July in an area (41°55', 83°17') off Detroit Beach (Patterson 1979).

Raisin River (41°53', 83°20'). Larvae appear to be more abundant in the river than in the lake; spawning probably occurs in the marshy and protected shorelines of the river (Cole 1978b).

Whitewood Creek (41°48', 83°26'). In 1975, a few larvae were collected in late July in an area (41°47', 83°26') just south of Whitewood Creek (Waybrant and Shauver 1979).

Ohio

O-3

Conneaut (41°58', 80°33'). In 1977, sunfish larvae were collected in Conneaut Harbor (41°58', 80°33') and in Lake Erie at nearshore and offshore sites near Turkey Creek (41°58', 80°32') in late June and early

July. Larvae were most abundant in the mouth of Turkey Creek. The abundance of larvae in the nearshore area probably reflects a movement of larvae into the lake from Turkey Creek (Aquat. Ecol. Assoc. 1978c).

Ontario

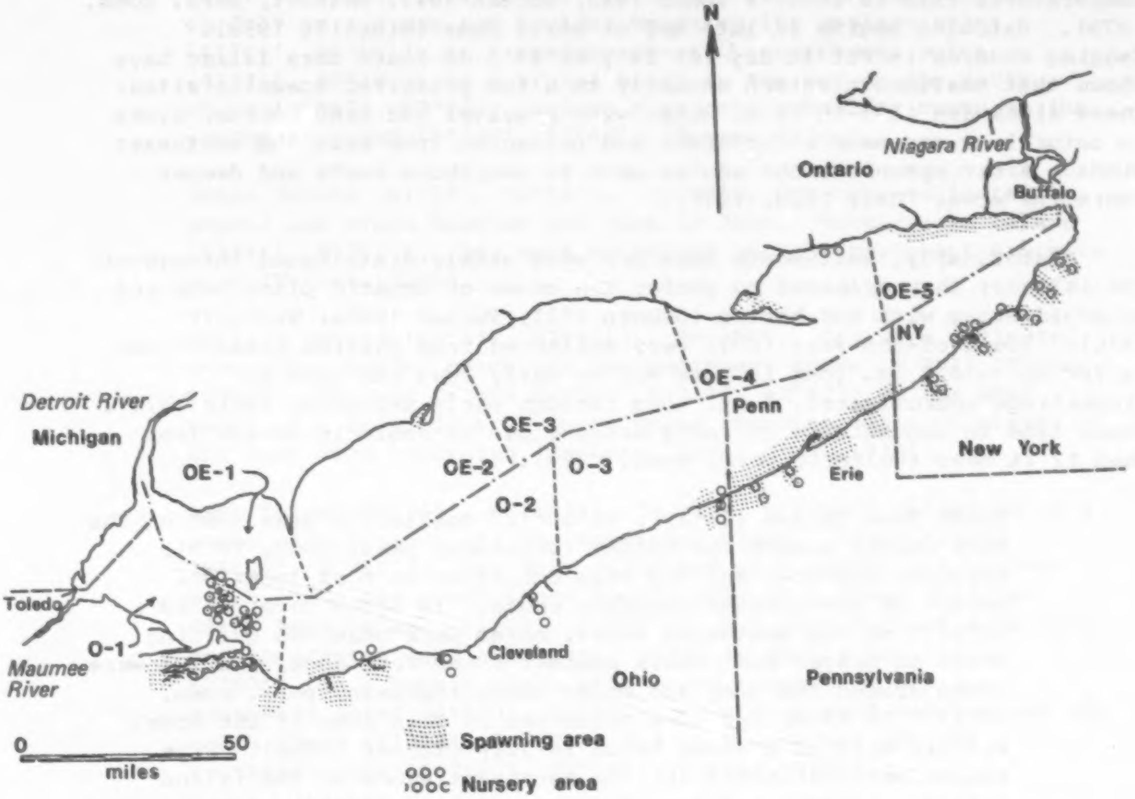
OE-1

Point Pelee (41°55', 82°30'). The marshes of Point Pelee National Park (41°58', 82°32') are important spawning areas (Environ. Can. 1977a).

OE-2

Rondeau Harbour (42°15', 81°53'). The marshes and open water areas of the bay are important spawning areas (Environ. Can. 1977a).

SMALLMOUTH BASS


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
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O-3
New York
Erie
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Smallmouth bass spawn inshore on shallow, rocky shoals in Lake Erie; they also enter tributaries to spawn (Trautman 1957, pers. comm. 1979). Historically, spawning occurred in May to early July (Fish 1932; Jordan 1877; Rathbun and Wakeham 1897).

Ohio

After 1810, many dams on Ohio streams blocked spawning migrations, and siltation also degraded spawning areas (Trautman 1957).

O-1

Smallmouth bass spawn in shallow bays on the islands and also in tributaries (Langlois 1954).

Bass Islands (41°41', 82°49'). The islands provide protected areas and excellent gravel and rubble substrate for spawning (Hair 1979). Spawning occurs from mid-May to the end of June, over rock, gravel, or sand bottom, usually in areas protected from wave action but with a current. Ripe adults are observed in waters as deep as 12-15 ft, but spawning usually occurs in 2-4 ft of water. Spawning begins when temperatures rise to 59-60°F (Doan 1942; Jordan 1877; Wolfert, pers. comm. 1979). Hatching begins in late May or early June (Wickliff 1938). Tagging studies in Put-In-Bay (41°39', 82°49') on South Bass Island have shown that smallmouth return annually to a few preferred spawning sites; these sites are in 6-10 ft of water with a gravel and sand bottom, close to natural or man-made structures, and protected from east and northeast winds. After spawning, the adults move to nearshore reefs and deeper shoreline areas (Hair 1978, 1979).

Historically, smallmouth bass fry were widely distributed throughout the islands; they appeared to prefer the edges of aquatic plant beds and to avoid areas with mud bottom (Osburn 1923; Turner 1920a; Wickliff 1920). Young-of-the-year (YOY) were collected from shallow areas, first as fry up to 0.5 in. long in late May or early June and then as fingerlings approximately 3 in. long through early September (Hair 1978). Young tend to concentrate in rocky areas close to shore in waters less than 12 ft deep (Wolfert, pers. comm. 1979).

> South Bass Island (41°39', 82°50'). Smallmouth bass nest on the rock shoals around the island (Trautman, pers. comm. 1979). Spawning occurred and fry were collected at most locations except on the extreme southern shore. In Stone Cove (41°38', 82°51') on the southwest shore, males were observed guarding nests on gravel and cobble against a concrete dock, and YOY were found around the dock and under boats (MacLean, pers. comm. 1979). In 1919, fry were collected in this area at the Hotel Victory site on a stone beach in July (Turner 1920a). Ripe adults were collected off the northeast shore of the island (41°39', 82°48') and around Buckeye Island (41°40', 82°47') over gravel, cobble, and rubble in 4-5 ft of water (MacLean, pers. comm. 1979). Historically, fry were abundant on the rubble beaches in these same areas (Turner 1920a). Put-In-Bay (41°39', 82°49') is a well-known spawning and nursery area. In 1919, fry were collected on stone and sand beaches in July off Peach Point (41°40', 82°50'), Gibraltar Island (41°39', 82°49'), and East Point (41°40', 82°48'), and along the south shore of Squaw Harbor (41°39', 82°49') (Turner 1920a). In 1938-41, nesting was observed from mid-May to late June, and young fry were collected near Hatchery Bay (41°39', 82°49'), Gibraltar Island, and Put-In-Bay Harbor (Doan 1942; Langlois 1954). In 1975-77, fry about 0.4-1.3 in. long were collected at Peach Point, Gibraltar Island, the Fish Hatchery dock, and the city docks in June to September (Hair 1979). Running-ripe males were collected over rock and gravel at Miller's Dock off East Point and at old stone cribbings in the harbor. Many males and subsequently swarms of young were collected at Nate's Dock in the harbor. Concentrations of YOY were found over boulders, cobble, and gravel on Alligator Bar (41°39', 82°49') between Gibraltar Island and Oak Point (41°39', 82°49') (MacLean, pers. comm. 1979).

Middle Bass Island (41°41', 82°49'). Running ripe males were collected in late May to early June off the western point of the island at 41°41', 82°50' over gravel and cobble in 3-5 ft of water (MacLean, pers. comm. 1979). In 1919, fry were collected in July on a stone and boulder beach on the western point (41°41', 82°50'), on a sand beach on the northwest point (41°41', 82°49'), on a gravel beach in the bay on the north shore (41°42', 82°48'), and on a stone and boulder beach on the southeast point (41°40', 82°48') (Turner 1920a).

Green Island (41°39', 82°52'). In 1919, fry were collected on gravel and stone beaches and bars in July. Rattlesnake Island (41°41', 82°51'). Fry were collected off the southeast shore in July (Turner 1920a).

Ballast Island (41°41', 82°47'). In 1919, fry were collected on a steep gravel beach off the southwest shore in July (Turner 1920a). Ballast Island Harbor (41°41', 82°47') on the west shore is a spawning area where males guarding nests on gravel and rock were collected (MacLean, pers. comm. 1979).

Lost Island (41°41', 82°47'). In 1919, fry were collected on a steep gravel beach off the northeast shore. Sugar Island (41°42', 82°49'). Fry were collected on a gravel and boulder beach along the north shore on the edge of a dense weed bed. North Bass Island (41°43', 82°49'). Fry were collected in July on a protected sand and gravel beach in Manila Bay (41°43', 82°50'), on a rubble beach with dense vegetation off the southwest point (41°43', 82°50'), on a fine sand beach along the south shore (41°42', 82°49'), and on a sand bar off the southeast point (42°42', 82°48') (Turner 1920a).

Gull Island Shoal (41°40', 82°41'). This spawning ground, which covered an estimated 30 acres, was the largest one among the islands. Nests were seen in the gravel or sand near every boulder (Jordan 1877).

Kelleys Island (41°36', 82°42'). Ripe fish were collected around the island in areas of strong current and emergent vegetation in late May and early June. Young were observed in rocky areas close to shore in less than 12 ft of water (Wolfert, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). The bay is a minor spawning area (FWS 1979d). In 1961-63 and in the 1970s, a few fry were collected in the bay (Hartley 1975; Hartley and Herdendorf 1975; Keller 1964a). In the early 1900s, smallmouth bass migrated up the Sandusky River (41°27', 82°59') to Fremont to spawn; but it was not known if these fish were from Lake Erie (Van Oosten 1926).

O-2

Huron River (41°24', 82°33'). Smallmouth bass enter the river to spawn in late April to early June (Cleveland Environ. Res. Group, undated; FWS 1979d; Teater 1976).

Chappel Creek (41°24', 82°27'). The substrate along the shoreline near the creek is favorable for spawning (Rawson, pers. comm. 1979).

Vermilion River (41°26', 82°22'). Smallmouth bass enter the Vermilion River in May and June. Spawning occurs in shallow water in and adjacent to the river (Odin 1975; Teater 1976; U.S. Army Eng. Dist. 1976a).

Beaver Creek (41°26', 82°15'). Historically, spawning runs entered the creek (Langlois 1945b). In 1979, late postlarvae were collected off the creek mouth in July in water 12 and 23 ft deep (Commonw. Assoc. 1979).

Rocky River (41°30', 81°50') and Chagrin River (41°41', 81°26'). In 1972-74, fry or YOY were collected in the lower reaches of the rivers; these may be spawning areas (White et al. 1975).

O-3

Conneaut (41°58', 80°33'). Large runs of smallmouth bass entered the Conneaut River (41°58', 80°33') each spring, prior to the construction of dams on the river (Langlois 1945b). In Conneaut Harbor (41°58', 80°33'), smallmouth bass spawn on the east side of the breakwall over large stone blocks (White, pers. comm. 1979). Spawning also occurs in the west corner of the harbor over sand and gravel with emergent vegetation (Odin 1979). In 1977, gravid females were collected between the Conneaut River and Raccoon Creek (41°59', 80°29'), in late June to late July; water temperatures were 66-68°F during late June. In 1977, larvae were collected near Turkey Creek (41°58', 80°32') on June 19 (Aquat. Ecol. Assoc. 1978c); the creek was a nursery area in summer and fall (USACE, undated b).

Pennsylvania

Smallmouth bass spawn in creek mouths along the Pennsylvania shoreline and also along shore in 16 ft or less of water over rock and rubble substrate. The adults move out into 36-42 ft of water after spawning. Substrate in the creeks includes sand, silt, and mud to rubble and gravel; current is moderate to low; and vegetation is usually present (Kenyon, pers. comm. 1979).

Raccoon Creek (41°59', 80°29'). Nest building was observed and ripe adults were collected in the creek mouth (Kenyon, pers. comm. 1979).

Crooked Creek (42°00', 80°26'). Nest building was observed and ripe adults were collected in the creek mouth. Concentrations of adults were found in May and early June on the 17-ft rock shoal (42°01', 80°25') off the creek mouth (Kenyon, pers. comm. 1979).

Elk Creek (42°01', 80°22'). Nest building was observed and ripe adults were collected in the creek mouth; the creek is a nursery area (GPU Serv. Corp. 1974; Kenyon, pers. comm. 1979).

Walnut Creek (42°04', 80°14'). Nest bulding was observed and ripe adults were collected in the creek mouth; the creek is a nursery area (Kenyon, pers. comm. 1979).

Sixmile Creek (42°11', 79°59') and Twelvemile Creek (42°13', 79°55'). Nest building was observed and ripe adults were collected in the creeks (Kenyon, pers. comm. 1979).

Sixteenmile Creek (42°14', 79°50'). Nest building was observed and ripe adults were collected in the creek (Kenyon, pers. comm. 1979). Concentrations of adults were also seen just offshore near the mouth of the creek in May and early June (Kenyon, pers. comm. 1979).

New York

Chautauqua Creek (42°20', 79°36'). Adults guarding nests were observed in the creek in June over rock and gravel in 2-4 ft of water; YOY were collected in July and August (Griswold and Galati, pers. comm. 1979).

Van Buren Bay (42°27', 79°25'). Spawning may occur in the bay; prolarvae and postlarvae were collected here in mid-August (Tex. Instrum. 1977a).

Point Gratiot (42°28', 79°23'). This is a nursery area; YOY were collected here in late August in 30-60 ft of water over rock and bedrock substrate (Griswold and Galati, pers. comm. 1979).

Canadaway Creek (42°28', 79°22'). Adults guarding nests were observed in June over rock and gravel in 2-4 ft of water, and YOY were collected in July and August (Griswold and Galati, pers. comm. 1979).

Dunkirk Harbor (42°30', 79°20'). The harbor is a prime spawning and nursery ground for smallmouth bass (NYDEC 1977b); adults apparently prefer to spawn on the sand bottom and rock breakwater at the eastern end of the harbor (Tex. Instrum. 1977d). Ripe and spent fish were found here (Tex. Instrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). Adults guarding nests were observed in June, and fry were collected in July and August among vegetation in 2-4 ft of water (Griswold and Galati, pers. comm. 1979).

Silver Creek (42°33', 79°10'). The littoral zone off the creek mouth is a spawning area (NYDEC 1977b). Adults have been observed guarding nests in June, and YOY are found here in July and August (Griswold and Galati, pers. comm. 1979).

Cattaraugus Creek (42°34', 79°08'). Spawning occurs in early June, and YOY are found in late summer (Griswold and Galati, pers. comm. 1979).

Big Sister Creek (42°40', 79°04'). Fry and YOY were collected in the creek over gravel, rock, and bedrock in July, August, and September; this is probably both a spawning and nursery area (Griswold and Galati, pers. comm. 1979).

Eighteenmile Creek (42°43', 78°58'). Fair spawning runs enter the creek in the spring (Buffalo Waterfront Dev. Comm., undated). Young-of-the-year were found in the creek over gravel and stone in 3-6 ft of water in September and October (Griswold and Galati, pers. comm. 1979). In 1928, fry about 0.5-0.8 in. long were taken at the mouth of the creek in mid-July (Fish 1929, 1932; Greeley 1929).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). Some smallmouth bass nests were found, but spawning sites appear limited by wind exposure (Loftus 1948).

OE-4

Long Point Bay (42°40', 80°10'). Smallmouth bass migrate westward along the north shore of Long Point Bay into Inner Bay (42°37', 80°22') (Chamberlain 1976b; Hamley 1979; Hamley and MacLean 1979; Teleki 1975b; Teleki et al. 1977). During the past 60 years, the main spawning grounds of smallmouth bass have shifted from the north shore to the south shore of Inner Bay, and east along the south shore toward the mouth of Inner Bay. In the late 1880s, many more smallmouth bass spawned at Turkey Point (42°39', 80°21') than at present. In the mid 1890s, documented spawning grounds were in the marsh south of Port Rowan (42°38', 80°27'), in Sturgeon Bay (42°36', 80°23'), and Rice Bay (42°36', 80°20'), and from Pottohawk Point (42°37', 80°17') along the south shore. In the 1930s, smallmouth bass spawned around Becker's Point (42°36', 80°25') and Old Cut Point (42°36', 80°24'); in the 1940s, spawning shifted to waters off Thoroughfare Point (42°36', 80°20'). A fair amount of spawning still occurs in some of the historic locations (Whillans 1977), but spawning in the Inner Bay area now occurs mainly between Thoroughfare Point and Pottohawk Point and in the more open, sandy areas south of Pottohawk Point in the Outer Bay (Hamley and MacLean 1979; Kerr and Kerr 1860-1898; Whillans, 1977, 1979b, pers. comm. 1979). Rice Bay, Sturgeon Bay and Whitefish Bay (42°39', 80°21') were still regarded as spawning areas in 1953, as were many sheltered coves along the entire south shore and along the north shore from St. Williams (42°40', 80°24') to Deep Hole Point (42°39', 80°20') (Berst 1953a,b). Reproducing populations are also probably established in some of the larger lagoons at the end of Long Point (42°33', 80°05') (Mahon 1977). In Long Point Bay and Inner Bay, ripe females are found at water temperatures greater than 64°F; nest building begins in late May or early June, and most egg deposition occurs in the latter half of June or early July (Berst 1953a,b; Teleki 1975a,b). In the 1940s, fry were not found in nests until late June (Ont. Game Fish 1944). Collections of YOY indicate several areas near Inner Bay and Nanticoke (42°48', 80°04'), including Peacock Point (42°47', 79°59'), are nursery areas (Kelso 1972); YOY are generally not found in the marshes (Hamley and MacLean 1979).

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OE-5

Grand River (42°51', 79°35')--Fort Erie (42°53', 78°56'). Spawning occurs on sandy beaches along this shoreline from 1 mi W of the Grand River to Fort Erie at the head of the Niagara River. Specific locations identified are Rock Island (42°52', 79°26'), Gravelly Bay (42°53' 79°16'), and Abino Bay (42°51', 79°05') (Environ. Can. 1977a).

LARGEMOUTH BASS

In Lake Erie, the largemouth bass historically spawned in early April to July (Fish 1932).

Ohio

O-1

Catawba Island (41°35', 82°51'). Largemouth bass reproduced in the enclosed harbors of Catawba Island (Osburn 1923). Fry were collected in Reedy Marsh at West Harbor (41°34', 82°49') (Turner 1920a). Largemouth bass were very abundant in East (41°32', 82°47'), Middle (41°33', 82°49'), and West Harbors where they spawned on sandy bottom among the vegetation. East Harbor contained six spawning areas, one of which was over 2 acres in size (Van Oosten 1926).

South Bass Island (41°39', 82°50'). In 1919, fry were collected in the bay on the northeast side of the island (41°39', 82°49') over a rubble beach with filamentous algae; in Stone Cove near the Hotel Victory site (41°38', 82°51') over a stony beach; and in Put-in-Bay (41°39', 82°49'), including Squaw Harbor (41°39', 82°49') over sand, mud, and vegetation; at Peach Point (41°40', 82°50') on a flat stone bar; off the southwest tip of Gibraltar Island (41°39', 82°49') over a flat stone bar; and in marshy, mud areas of Terwilliger Pond (41°39', 82°50') (Turner 1920a).

Green Island (41°39', 82°52'). A few fry were collected off the east and the west points of the island. Middle Bass Island (41°41', 82°49'). Young-of-the-year (YOY) were collected on the northern shore (41°42', 82°48') among boulders and submergent vegetation. North Bass Island (41°43', 82°49'). Fry were collected on the south shore (41°42', 82°49') over fine sand bottom with no vegetation (Turner 1920a).

Sandusky Bay (41°29', 82°46'). This is a minor spawning area for largemouth bass (FWS 1979d).

O-2

Old Woman Creek (41°23', 82°31'). The estuary is excellent largemouth bass spawning habitat (FWS 1979d).

Lorain Harbor (41°28', 82°11'). Largemouth bass were observed spawning in the harbor (White, pers. comm. 1979).

Cleveland (41°30', 81°43'). Largemouth bass spawn in Cleveland Harbor (41°31', 81°42') (White, pers. comm. 1979). In 1972-74, adults were observed guarding nests, and a few YOY were collected in the harbor. A few YOY were also collected in the lower Rocky River (41°30', 81°50'); this may be a spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). A few YOY were collected in the lower river; this may be a spawning area (White et al. 1975).

O-3

Conneaut (41°58', 80°33'). In 1977, YOY were collected in the lower Conneaut River (41°58', 80°33') and lower Turkey Creek (41°58', 80°32') in July and August. No adults were collected in these streams, but a few larvae were collected in the Conneaut River; YOY in these streams may be due to limited spawning in the nearshore area or they may be strays from Lake Erie (Aquat. Ecol. Assoc. 1978c; USACE, undated b). A few largemouth bass larvae were captured nearshore, immediately east of the Conneaut Harbor (41°58', 80°33') breakwall (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Raccoon Creek (41°59', 80°29'). In 1977, YOY were collected in the creek after July. Few adults were found, and there was no evidence of a resident population. The presence of YOY was attributed to limited spawning in the creek or the use of the creek as a nursery area by strays from Lake Erie (Aquat. Ecol. Assoc. 1978c).

Presque Isle Bay (42°08', 80°07'). The lagoons and shallows of the north and west shores of Presque Isle Bay, including Thompson Bay (42°10', 80°05') and Horseshoe Pond (42°10', 80°05') are spawning areas (Larsen, pers. comm. 1979).

Ontario

OE-2

Rondeau Harbour (42°15', 81°53'). Historically, this was a spawning area (Kerr and Kerr 1860-1898). In the late 1940s to 1950, spawning occurred in the extensive marshy, lagoon areas in June, when the water temperature reached about 65°F; nests, eggs, and fry were observed. The largest spawning area was "the Ponds" on the southeast side of the bay. Nests were also seen on the southwest shore between Erieau (42°14', 81°55') and Rondeau (42°18', 81°55'). Large schools of fingerlings were seen along the northeast shore in late June (Berst 1950; Loftus 1948).

OE-4

Long Point Bay (42°40', 80°10'). Largemouth bass spawned in Long Point Marsh (42°35', 80°17') and in an area east of Port Rowan (42°38', 80°27') on the north shore of the bay. In the late 1880s, largemouth bass spawned at Turkey Point (42°39', 80°21'). In the mid-1890s, spawning was documented in the marsh south of Pottohawk Point in the outer bay, from Old Cut (42°35', 80°24') to Pottohawk Point (42°37', 80°17') in Rice Bay (42°36', 80°20'), in Sturgeon Bay (42°36', 80°23'), and in marsh areas south of Port Rowan. At the turn of the century, the main spawning grounds extended from Pottohawk Point to Rice Bay along the south shore (Kerr and Kerr 1860-1898; Whillans 1977, 1979b). Largemouth bass presently spawn the marsh inside Ryerson's Island (42°36', 80°17'), Big Creek Marsh (42°36', 80°27'), and in Turkey Point Marsh (Whillans, pers. comm. 1979). Spawning also occurs in Long Point Crown Marsh (42°35', 80°25'), at the base of Long Point, in May (Reid 1978). Reproducing populations are resident in the larger lagoons on Long Point (42°33', 80°10') (Mahon 1979; Mahon and Balon 1977b). In late 1928, YOY were seined in Long Point Bay in late August (Fish 1932). In 1976, YOY were collected in seines at the Nanticoke Generating Station (42°48', 80°03') (Chamberlain 1976); more recently, YOY were collected in the Long Point marshes (Hamley and MacLean 1979; Reid 1978).

OE-5

Abino Bay (42°51', 79°05'). This is a spawning and nursery area for the largemouth bass (Environ. Can. 1977a).

BLACK BASS

Michigan

Swan Creek (41°58', 83°15'). In 1975, a few larvae were collected in an area (41°59', 83°14') along the beach just north of the mouth of the creek in mid- to late June (Waybrant and Shauver 1979).

Stony Creek (41°57', 83°18'), Sandy Creek (41°56', 83°20'), and Plum Creek (41°54', 83°22'). From 1949 to the 1970s, black bass spawned in the lower reaches of the creeks over sand and rock (Organ et al. 1978).

Pennsylvania

Erie (42°07', 80°05'). Historically, fishermen caught black bass in Erie Harbor during the spawning season (Meehan 1895).

Ontario

OE-1

Point Pelee (41°55', 82°30'). The marshes of Point Pelee National Park (41°58', 82°32') are important spawning areas (Environ. Can. 1977a).

OE-2

Rondeau Harbour (42°15', 81°53'). The marshes and also the open water areas are important spawning areas (Environ. Can. 1977a).

OE-4

Inner Bay (42°37', 80°22'). This is an important spawning area for black bass (Environ. Can. 1977a). Historically, spawning occurred near Port Rowan (42°38', 80°27') in May (Ont. Game Fish 1911).

WHITE CRAPPIE

Ohio

O-1

Maumee Bay (41°43', 83°25'). White crappie spawn in the bay in May (Pinsak and Meyer 1976).

Locust Point (41°36', 83°05'). Spawning occurs in the Davis-Besse Power Plant intake canal (41°36', 83°04') (Reutter 1979a). Many YOY are impinged at the plant, and many fry were collected on the bottom of the canal (CLEAR 1975b; Reutter 1979a).

South Bass Island (41°39', 82°50'). White crappie spawned in a warm shallow pool at South Bass Island in mid-June (Langlois 1954).

Sandusky Bay (41°29', 82°46'). The bay is a spawning site for white crappie in May and June; young-of-the-year (YOY) have been found throughout the bay (Chapman 1955; Keller 1964a).

O-2

Old Woman Creek (41°23', 82°31'). The estuary contains excellent spawning habitat for white crappie (FWS 1979d).

Rocky River (41°30', 81°50'). Spawning runs entering the river peak in the second week in May (Cleveland Environ. Res. Group, undated; White, pers. comm. 1979). In 1972-74, a few YOY were collected in the lower river (White et al. 1975).

Cleveland (41°30', 81°43'). A few fry were collected in Cleveland Harbor (41°31', 81°42'); this could be a spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). Spawning runs entering the river peak in the second week of May (White, pers. comm. 1979). In 1972-74, fry were collected in the lower river and along the adjacent shoreline of the lake (White et al. 1975). In 1975, a few prolarvae were collected at the East Lake Power Plant (41°40', 81°27') near the Chagrin River in June and July. Spawning is assumed to have occurred in the immediate area or in the mouth of the river (Aquat. Ecol. Assoc. 1976b).

BLACK CRAPPIE

Ohio

O-1

Maumee Bay (41°43', 83°25'). Black crappie spawn in May and June in the bay (Pinsak and Meyer 1979).

Locust Point (41°36', 83°05'). Black crappie spawn in the intake canal of the Davis-Besse Power Plant (41°36', 83°04') (Reutter 1979a). In 1975, a few fry were collected nearshore in mid-June, and many young-of-the-year (YOY) are impinged at the plant (CLEAR 1975b; Reutter 1979a).

Sandusky Bay (41°29', 82°46'). Black crappie spawn here in May and June; YOY are widely distributed throughout the bay (Chapman 1955).

O-2

Old Woman Creek (41°23', 82°31'). The estuary contains excellent spawning habitat for black crappie (FWS 1979d).

Rocky River (41°30', 81°50'). Spawning runs peak in mid-May (Cleveland Environ. Res. Group, undated; White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Spawning runs entering the river peak in mid-May (White, pers. comm. 1979). Fry or YOY were collected in the lower river (White et al. 1975).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). Historically, black crappie spawned in Inner Bay (42°37', 80°22') (Kerr and Kerr 1860-1898) and spawning still occurs there along the marshy shore areas (Whillans, pers. comm. 1979).

In Long Point Crown Marsh (42°35', 80°25') spawning occurs in late May to early June, and YOY are abundant (Reid 1978). Reproducing populations also probably occur in the lagoons at the tip of the point (42°33', 80°05') (Mahon 1979).

CRAPPIE spp.

Michigan

Sterling State Park (41°55', 83°20'). Spawning occurs along the entire shoreline of the park over rock and mud (Organ et al. 1978).

Monroe (41°55', 83°24'). Crappies spawn in the discharge canal of the Monroe Power Plant (41°53', 83°21') (Organ et al. 1978).

Bay Creek (41°47', 83°27'). Crappies spawn off the mouth of the creek (Organ et al. 1978).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). Crappies spawn successfully in large numbers in the bay (FWS 1979d).

O-2

Cleveland (41°30', 81°43'). A major spawning area exists just inside the west marina in Cleveland Harbor (41°31', 81°42') (Odin 1979).

O-3

Conneaut (41°58', 80°33'). In 1977, larvae were captured offshore between the Conneaut River (41°58', 80°33') and Raccoon Creek (41°59', 80°29') in mid-July. Larvae were also collected in the Conneaut River during June and in the mouth of Turkey Creek (41°58', 80°32') in early June (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Presque Isle Bay (42°08', 80°07'). Crappies spawn in the shallow areas and lagoons on the north and west shores, including Thompson Bay (42°10', 80°05') and Horseshoe Pond (42°10', 80°05') (Larsen, pers. comm. 1979).

Ontario

OE-4

Inner Bay (42°37', 80°22'). In 1888, crappies were observed spawning at Turkey Point (42°39', 80°21'); they are still reproducing in the bay (Whillans 1977).

GREENSIDE DARTER

Ohio

O-1

South Bass Island (41°39', 82°50'). In 1919, fry were found during July on the east shore (41°39', 82°49') in shallow water on flat rock bottom, in which there were deep pools in depressions, and at Peach Point (41°40', 82°50') in 2 ft of water along a flat stony bar with no vegetation (Turner 1920a).

Middle Bass Island (41°41', 82°49'). Fry were found along the southeast shore (41°41', 82°48') in a few inches of water in patches of moss over flat rock (Turner 1920a).

RAINBOW DARTER

Pennsylvania

The rainbow darter is primarily a stream resident; along the Pennsylvania shoreline, it spawns in creek mouths and in the nearshore surge zone. Males in breeding color were observed in all tributaries in May, and concentrations of advanced young-of-the-year were collected along the lakeshore. The rainbow darter is usually found on rock and gravel bottom with little vegetation in water less than 1 ft deep with a fast current (Kenyon, pers. comm. 1979).

IOWA DARTER

Ontario

OE-4

Long Point (42°33', 80°10'). In 1977, 2% of the young-of-the-year fish collected in Long Point Crown Marsh (42°35', 80°25') in July were Iowa darters (Reid 1978). This darter is also probably established in the lagoons at the tip of Long Point (42°33', 80°05') (Mahon 1979).

FANTAIL DARTER

Ohio

O-1

South Bass Island (41°39', 82°50'). In 1919, fry were collected in July along the water's edge off the northeast point of the island (41°40', 82°47'); they were found in moss patches and under stones along a level rubble beach that was subject to constant wave action (Turner 1920a).

Middle Bass Island (41°41', 82°49'). Fry were found on the east shore (41°41', 82°48') of the island over a shallow flat rock bottom, either exposed or covered with sand, with some boulders and some submergent vegetation (Turner 1920a).

JOHNNY DARTER

In Lake Erie, the johnny darter spawns in May and June; this species attaches its eggs to the flat sides of stones or other objects about a foot below the surface (Fish 1932).

Ohio

O-1

Sandusky Bay (41°29', 82°46'). In 1961, young-of-the-year (YOY) were taken in small numbers in the western end of the bay from May to October (Keller 1964a).

O-2

Chagrin River (41°41', 81°26'). In 1972-74, YOY were collected in the lower river; this may be a spawning area (White et al. 1975).

O-3

Ashtabula (41°55', 80°47'). The johnny darter spawns in a small harbor on the eastern edge of Ashtabula in 10 ft of water over a stony, gravel substrate; larvae were collected there (White, pers. comm. 1979).

Pennsylvania

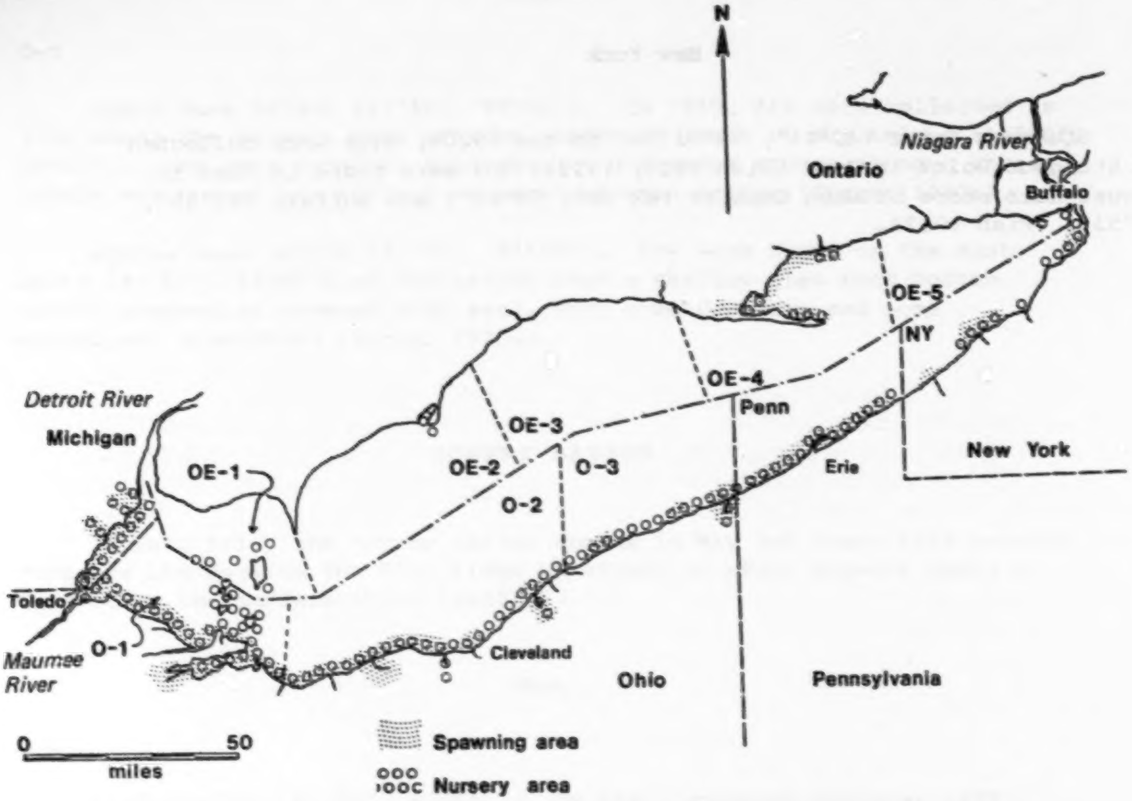
Young-of-the-year were collected from August to October all along the Pennsylvania shoreline at depths of 42-60 ft over a mud bottom with no vegetation (Kenyon, pers. comm. 1979).

Elk Creek (42°01', 80°22'). Larvae were collected off the creek mouth (GPU Serv. Corp. 1979).

New York

Sturgeon Point (42°41', 79°03'). In the 1920s, eggs were collected at Sturgeon Point in June (Fish 1929, 1932); YOY were found in June to August near shore between Dunkirk (42°29', 79°20') and Buffalo (42°55', 78°53') (Fish 1932).

YELLOW PERCH


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-1
OE-3
OE-2
O-3
O-2
Erie
New York
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In Lake Erie, spawning runs of yellow perch begin as early as April. Spawning occurs in shallow water along the shorelines and in tributaries in April and May when the water temperature reaches about 44-58°F. Eggs are deposited in flat, ribbon-like masses. Incubation usually lasts about 2 weeks, and hatching can occur as early as the first week of May and continue into July. In June, yellow perch larvae become free-swimming and move away from the shoreline (Barnett 1969; Bowman 1974; Doan 1942; Fish 1929, 1932; Jobes 1952; Teleki 1975b; Van Meter 1960; Van Oosten and Hile 1949). In 1928-29, larvae were abundant throughout the lake from June to August and were usually found in the shallow inshore areas (Fish 1932). Since 1958, young-of-the-year (YOY) have been abundant in the central basin from Erie, Pennsylvania (42°07', 80°05'), to Vermilion, Ohio (41°26', 82°22') (Anderson 1966; Baker 1969; Baker and Bower 1964, 1965; Baker and Scholl 1970, 1971; Bowman 1974; Parker 1964; Rudolph and Scholl 1969; Seward 1967, 1968; Van Vooren and Davies 1974; Van Vooren et al. 1977).

The western basin is the major spawning and nursery ground for Lake Erie yellow perch (Doremus 1975). Some of the yellow perch that spawn in the western basin in the spring migrate to the central basin after spawning and return to the western basin in the fall to overwinter

(Rawson, pers. comm. 1979). Yellow perch in the western basin apparently prefer to spawn in the nearshore waters at depths of 20 ft or less over sand, mud, and rooted aquatic vegetation (Rawson, pers. comm. 1979; Wolfert, pers. comm. 1979). Peak spawning occurs at water temperatures of about 50-54°F (Wolfert, pers. comm. 1979; Wolfert et al. 1975). Spawning success is positively correlated with high mean air temperature in May, rapidly increasing water temperature in April and May, and a low frequency of occurrence of strong winds (Scott et al. 1978b). Yellow perch do not usually spawn on the same sites used by walleyes in western Lake Erie (Wolfert et al. 1975).

Most hatching occurs May 1-15 when the water temperature reaches about 50°F (Comm. Fish. Rev. 1961a). Large numbers of yellow perch larvae are found throughout the western basin, but prolarvae are consistently concentrated at the bottom along beach fronts and nearshore areas (Baker 1966b; Baker and Scholl 1971c; Cole 1978a; Heniken 1977; Manz 1960, 1963; Waybrant and Shauver 1979). Older postlarvae are widely distributed; either spawning occurs over a very wide area or the larvae are widely dispersed soon after hatching (Cole 1978a; Waybrant and Shauver 1979). Considerable mixing of larvae from separate spawning areas in the western basin can occur: up to 50% of the larvae hatched within about 1/2 mi of the Michigan shoreline could be carried by currents into international waters within 10 days (Patterson 1979b). Large numbers of larvae also enter the basin from the Detroit River (42°03', 83°08') (Cole 1978b; MacMillan 1976; Waybrant and Shauver, undated).

In the 1920s, fry and eggs were collected in the western basin from mid-May to early September at depths of less than 13 ft; greatest concentrations occurred along the south and southwest shores from Marblehead Point (41°32', 82°43') to Monroe (41°55', 83°24') and among the Bass Islands (41°41', 82°49') (Wickliff 1928a). Many larvae were also found to depths of 66 ft (Fish 1929). Peak numbers of YOY are generally found during the last week of July in shallow, inshore areas (Van Vooren et al. 1975).

Michigan

Spawning occurs along the entire shoreline south from Stony Point (41°56', 83°16') over clay, mud, sand, gravel and aquatic vegetation (Organ et al. 1978). In 1975, yellow perch larvae were abundant along the beach area from the Raisin River (41°53', 83°20') to the Maumee River estuary (41°41', 83°28'); they were less abundant north of the Raisin River (Patterson 1979b). In 1976, larvae were abundant along the west shore of the western basin (Cole 1978a).

Huron River (42°02', 83°12'). This is a spawning and nursery area. Larvae move from the river into the lake (Patterson 1979b).

Pointe Mouillee (42°01', 83°12')--Swan Creek (41°58', 83°15'). Yellow perch spawn in Swan Creek, and larvae move out of the creek into the lake (Patterson 1979b). In 1935-68, yellow perch spawned in an area (41°59', 83°12') at the 6 ft depth contour 2 mi offshore, halfway between Pointe Mouillee and Swan Creek (Organ et al. 1978). Ichthyoplankton samples near the Fermi Power Plant (41°57', 83°15') were dominated by yellow perch larvae, most of which were early postlarvae (Detroit Edison 1978); yellow perch larvae were entrained at the plant in June (Detroit Edison 1976g). In 1976, yellow perch larvae were found along the beach (41°59', 83°14') just north of Swan Creek (Waybrant and Shauver 1979).

Brest Bay (41°55', 83°18'). Spawning occurs throughout the bay over mud and clay (Organ et al. 1978). The backwater area from Stony Point (41°56', 83°16') along the north shore of the bay (41°56', 83°18') is a major spawning and nursery area. This area has rooted aquatic vegetation, a depth of 4 ft, and little current. Spawning occurs in May at a water temperature of 48°F. Larvae 3 to 4 days old move from the spawning area into the bay (Thomas, pers. comm. 1979). In Michigan waters, YOY are more abundant off Sterling State Park (41°55', 83°20') than in areas to the south (Jaworski and Raphael 1978b; MDNR 1970-76).

Monroe (41°55', 83°24'). Spawning occurs along shore throughout this area (Organ et al. 1978). The Monroe Power Plant (41°53', 83°21') is located near one of the largest yellow perch spawning areas in Lake Erie. Egg masses are entrained and accumulate on plant intake trash racks and screens in mid-May; many larvae are entrained in early June (Detroit Edison 1976h; Parkhurst 1971). There is a concentration of yellow perch larvae in June in the lower Raisin River (41°53', 83°20'); prolarvae are most abundant in the lower river, and postlarvae are most abundant in surrounding lake waters. The first larvae usually appear in collections in mid-May and most are taken before mid-June (MacMillan 1976; Nelson 1975; Nelson and Cole 1975; Patterson 1979b). In 1973-74, larvae were abundant in May in the mouth of the Raisin River and in the plant discharge canal (Cole 1976).

La Plaisance Bay (41°52', 83°22'). Spawning occurs throughout the bay over mud and clay (Organ et al. 1978). The area is a turbid backwater about 10 ft deep with rooted aquatics and little current. Water temperature during spawning is about 48°F. Larvae 3 to 4 days old move from the inshore area into the surrounding lake waters (Thomas, pers. comm. 1979). The bay is a nursery area; in 1970, YOY were most abundant in the bay in August (Parkhurst 1971).

Toledo Beach (41°50', 83°24'). In 1977, the highest densities of prolarvae and early postlarvae were found at Toledo Beach in early May (Patterson 1979a).

Woodtick Peninsula (41°44', 83°25'). Spawning occurs over gravel along the entire shoreline (Organ et al. 1978). In 1975, larvae were abundant along shore (41°48', 83°26') just north of the Woodtick Peninsula (Waybrant and Shauver 1979). In 1978, maximum impingement of yellow perch at the Whiting Power Plant (41°47', 83°27') occurred in April; these fish were mainly adults that had moved to the shallows to spawn. Larvae were entrained at the plant and collected near the plant in May and June (Wapora 1979b).

Ohio

O-1

The entire south shore of the western basin of Lake Erie is a yellow perch spawning and nursery area (Wolfert, pers. comm. 1979; Wickliff 1928a; CLEAR 1978).

Maumee Bay (41°43', 83°25'). Yellow perch spawn in the bay on the spoil areas along the channel, from April 15 to May 5 (Pinsak and Meyer 1976; U.S. Army Eng. Dist. 1976). Ripe or gravid adults were observed, and eggs were collected at a beach west of Cedar Point (41°42', 83°20'), over hard sand, clay, and gravel in water shallower than 20 ft (Rawson, pers. comm. 1979). Yellow perch larvae were collected in the bay and the Maumee River estuary (41°41', 83°28') and were most abundant on the bottom (CLEAR 1977; Reutter, Herdendorf, and Sturm 1978a,b; Patterson 1979b; Paul and Patterson 1977). The east side of the river mouth (41°42', 83°27') is a major nursery area; large concentrations of YOY yellow perch were documented here. This area to water depths of 3 ft has a silt-mud substrate, and dense, diverse strands of macrophytes (Fraleigh, pers. comm. 1979). In 1975-77, larvae were collected in the bay from April to June. The lack of perch larvae in the river indicated that spawning occurred primarily in the bay, possibly around the dredge disposal dike (Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Snyder 1978).

Cedar Point (41°42', 83°20')--Reno Beach (41°40', 83°16'). This is a major spawning area for yellow perch. Adults move inshore to spawn and return to offshore waters after spawning. Ripe adults were observed here, and eggs were collected in this area at the end of April; at depths of 3-20 ft the bottom is hard clay with patches of soft mud and gravel (Rawson, pers. comm. 1979; Reynolds, pers. comm. 1979; Wolfert, pers. comm. 1979).

Metzger Marsh (41°39', 83°14'). In 1975, larvae were abundant just off the marsh in late April (Herdendorf et al. 1976). In 1977, prolarvae and postlarvae were collected off Ward Canal (41°39', 83°14') in early May (Patterson 1979a). In 1961, large numbers of YOY were also found off Potters Pond (41°41', 83°18') (Ayers et al. 1970).

Crane Creek (41°38', 83°12'). Young-of-the-year were abundant off the creek mouth (Baker and Scholl 1971c; Gehres and Scholl 1969).

Locust Point (41°36', 83°05'). Yellow perch fry are one of the most common fry in the area (Reutter and Herdendorf 1977). In 1974-75, large numbers of very small yellow perch larvae were found in mid-May near the intake and discharge structures of the Davis-Besse Power Plant (41°36', 83°04') (CLEAR 1975b, 1976; USNRC 1975b). Smaller numbers of larvae and YOY were found in June and July along shore and in the plant intake canal (CLEAR 1975a, 1976; Herdendorf et al. 1976; Patterson 1979a; Reutter and Herdendorf 1975). Yellow perch may be spawning on the riprap of the intake and discharge areas (CLEAR 1975b, 1976).

Catawba Island (41°35', 82°51'). In 1919, YOY were collected in West Harbor (41°34', 82°49') (Turner 1920a). More recently, ripe-running adults and eggs were collected from Lakeside (41°33', 82°45') to Scott Point (41°35', 82°50') over sand bottom in 20 ft or less of water (Rawson, pers. comm. 1979; Wolfert, pers. comm. 1979). Young-of-the-year were very abundant inside and outside East Harbor (41°32', 82°47') (Baker and Scholl 1971c; Hair and Scholl 1971; Rudolph and Scholl 1970; Van Vooren et al. 1978), and along the west side of Catawba Island (Ball and Scholl 1973). In late May to early June 1975 and late April to early May 1976, the greatest concentrations of larvae were found in the shallow inshore areas, particularly from Catawba Island west to the Portage River (41°31', 82°56'). This area has sandy to gravelly substrate with *Cladophora* as the main vegetation. The larvae collected were newly hatched, suggesting that spawning grounds were nearby, but these larvae could also have been carried to shore from the offshore reefs by southerly currents from the Detroit River (42°03', 83°08') (Heniken 1977).

Island Region (41°40', 82°45'). Young-of-the-year yellow perch have been abundant in collections on the shoals around the Bass Islands (41°41', 82°49') usually in June, July, and August (Baker 1967c; Langlois 1954).

South Bass Island (41°39', 82°50'). In 1919, YOY were collected along the northeast shore (41°39', 82°48'), in Put-in-Bay (41°39', 82°49'), Terwilliger Pond (41°39', 82°50'), at Gibraltar Island (41°39', 82°49'), and on the western shore near the Hotel Victory (41°38', 82°51') (Turner 1920a).

Ballast Island (41°41', 82°47'). Young-of-the-year were collected off the southwest tip of the island (Turner 1920a).

Middle Bass Island (41°41', 82°49'). Young-of-the-year were collected at the southeast (41°41', 82°48'), northeast (41°42', 82°48'), and northwest (41°41', 82°49') corners of the island (Turner 1920a).

Rattlesnake Island (41°41', 82'51'). Yellow perch larvae were collected off the north shore of the island (Turner 1920a).

North Bass Island (41°43', 82°49'). Young-of-the-year were collected along the southeast shore (at 41°42', 82°49' and 42°42', 82°48') and on the southwest point (41°43', 82°50') (Turner 1920a).

Kelleys Island (41°36', 82°42'). In early May 1976, the density of yellow perch larvae in this area was higher than elsewhere in the western basin (Heniken 1977).

Marblehead Light (41°32', 82°43'). In 1979, spawning adults were collected off Marblehead Light in 10-20 ft of water in April. After spawning, adults move away from the shore area. This is also a nursery area (Wolfert, pers. comm. 1979).

OE-4

Long Point Bay (42°40', 80°10'). Yellow perch begin to move inshore from deeper waters during mid-April when the water temperature rises to 43°F from approximately 35°F. Spawning occurs in 26-33 ft of water from mid-April to June, and peaks about the first 2 weeks of May. Spawning begins when water temperature reaches 43-50°F. In the western part of the bay, spawning begins, peaks, and ends 2 weeks earlier than in the eastern portion (Sztranko and Teleki 1977; Teleki 1975a,b; Teleki et al. 1977). In 1971, ripe males and females were collected throughout Long Point Bay; very few were found in Inner Bay (42°37', 80°22') (Kelso 1972). Short migrations occur along the north shore. The gravel ridge running eastward from Kitchen Point (42°47', 80°08') to the Stelco dock (42°47', 80°05') is a prime fishing ground during the spawning season and may be a spawning area (Hamley and MacLean 1979).

Inner Bay (42°37', 80°22') is a major spawning area (Environ. Can. 1977a). Yellow perch historically spawned in Big Creek (42°36', 80°27'), but access to the creek was blocked when a dam was constructed at the mouth in 1889. Although the route was opened again about 1895, the disruption was severe, and by 1930 yellow perch spawning in Inner Bay was limited to the north shore from Big Creek Marsh to Turkey Point Marsh (42°39', 80°21'). Spawning now occurs along the south shore of Long Point Bay and on Long Point (42°33', 80°10'), where yellow perch run into the lagoons in early April and early May; there may be resident reproducing populations in some of these lagoons (Mahon 1979, pers. comm. 1979; Mahon and Balon 1977a; Reid 1978). Yellow perch also spawn along the north shore from Port Rowan (42°38', 80°27') to St. Williams (42°40', 80°24') and from Fishers Glen (42°43', 80°18') to Port Dover (42<47', 80°12') (Whillans 1977, pers. comm. 1979).

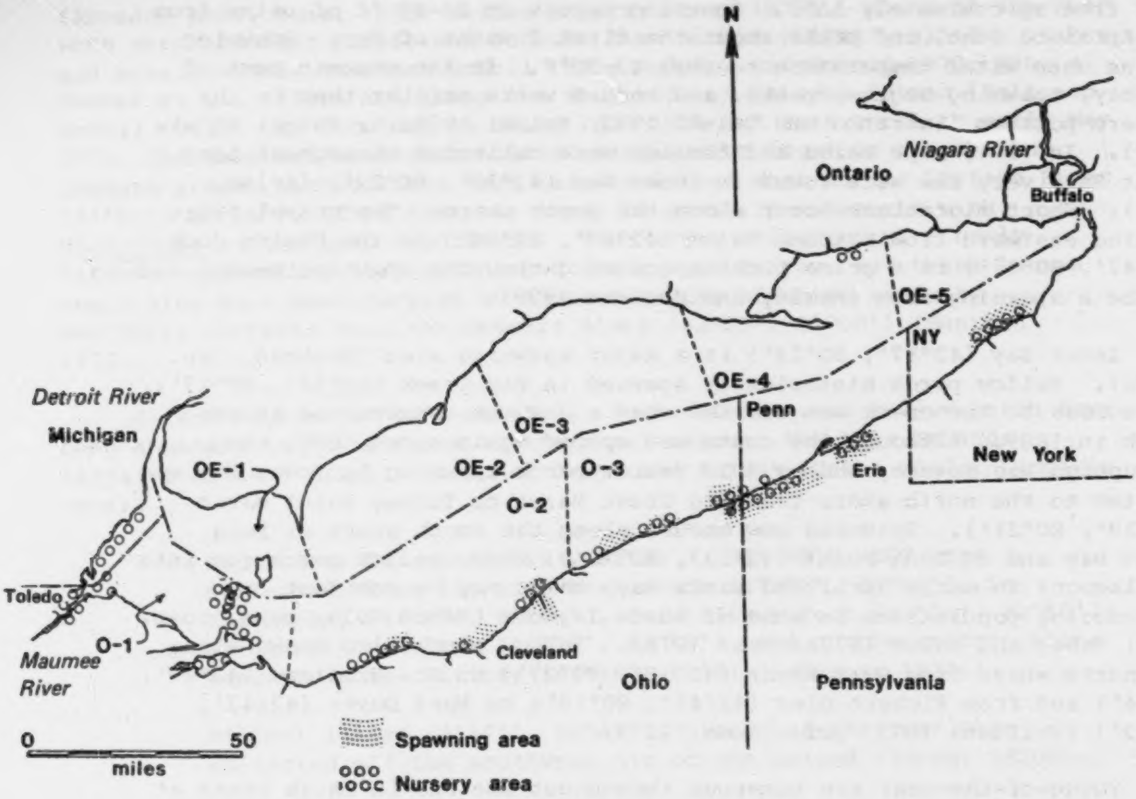
Young-of-the-year are numerous throughout the bay in marsh areas at the Long Point lagoons, Big Rice Bay (42°36', 80°20'), Long Point Crown Marsh (42°35', 80°25'), Big Creek, and at Nanticoke (42°48', 80°04') (Hamley and MacLean 1979; Kelso 1972; Mahon and Balon 1977a; Reid 1978; Teleki 1976; Whillans, pers. comm. 1979).

OE-5

Abino Bay (42°51', 79°05'). This is a spawning and nursery area (Environ. Can. 1977a).

Bertie Bay (42°53', 78°58'). In 1928, larvae were abundant in the area from Bertie Bay to Sturgeon Point (42°41', 79°03'), New York, in mid-July (Fish 1930).

LOGPERCH


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-1
OE-3
OE-2
O-3
O-2
Erie
New York
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

Michigan

Fermi Power Plant (41°57', 83°15'). In 1976, early postlarvae were collected in early July near the intake of the plant (Detroit Edison 1978).

Brest Bay (41°55', 83°18'). Larvae were abundant in Brest Bay (Cole 1978a; Patterson 1979a). In 1977, early postlarvae were collected in early June off Detroit Beach at 41°56', 83°19' (Patterson 1979a).

Whitewood Creek (41°48', 83°26'). In 1975, logperch larvae were collected along the beach (41°48', 83°26') north of Whitewood Creek in late June. Logperch larvae were generally more common in the southern portion of the Michigan waters; spawning occurs about 2 weeks earlier there than in more northern waters (Waybrant and Shauver 1979).

Ohio

O-1

Maumee Bay (41°43', 83°25'). In 1975 and 1977, larvae were collected throughout the bay in small numbers in April, June and July (Herdendorf 1977; Herdendorf and Cooper 1975). The Maumee River estuary (41°41', 83°28') is a nursery area (CLEAR 1977; Snyder 1978).

West Harbor (41°34', 82°49'). In 1919, fry were collected in an area with no aquatic vegetation, except Eleocharis (Turner 1920a).

South Bass Island (41°39', 82°50'). In 1919, fry were collected at many sites all around the island usually on shallow, gravel, sand, and rock beaches with little or no aquatic vegetation. Fry were found at the Hotel Victory site in Stone Cove (41°38', 82°51'), off Peach Point (41°40', 82°50'), off East Point (41°40', 82°48'), off the northeast tip (41°40', 82°48'), and in the bay along the east shore (41°39', 82°48'). Green Island (41°39', 82°52'). Fry were collected off the west and east ends of the island on protected gravel and stone beaches. Lost Island (41°41', 82°47'). In 1919, fry were collected on a steep, gravel beach with pondweed. Middle Bass Island (41°41', 82°49'). Fry were collected in rocky beach areas off the southeastern side of the island at 41°40', 82°48' and 41°41', 82°48', and on a sandy beach with much aquatic vegetation off the northwest tip of the island (41°41', 82°49'). North Bass Island (41°43', 82°49'). Fry were collected on rubble and sand beaches both with and without aquatic vegetation, off the southeastern end of the island at 41°41', 82°49' and 42°42', 82°48' (Turner 1920a).

Sandusky Bay (41°29', 82°46'). In the 1960s, a few young-of-the-year (YOY) logperch about 1.0-3.4 in. long were collected in the western portion of the bay from May to October (Baker 1966b; Keller 1964a). The Sandusky River estuary (41°27', 82°59') is a nursery area (CLEAR 1977).

O-2

Beaver Creek (41°26', 82°15'). In 1979, early and late postlarvae were collected out to the 36 ft depth contour off the creek mouth from late June to late August (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). Logperch larvae were collected in Lorain Harbor (41°28', 82°11'); only 1% of the catch of larvae here were logperch (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, a few prolarvae were collected near the plant in June (Aquat. Ecol. Assoc. 1975).

Cleveland (41°30', 81°43'). Logperch spawn on the beach at Lakewood (41°30', 81°47') approximately 3-1/2 mi E of the mouth of the Rocky River; logperch spawn in this area on slightly larger rocks than do longnose dace (White, pers. comm. 1979). In 1972-74, a few YOY or fry were collected in Cleveland Harbor (41°31', 81°42'); this may be a spawning area (White et al. 1975).

Chagrin River (41°41', 81°26'). In 1975, logperch prolarvae were in the vicinity of the Eastlake Power Plant (41°40', 81°27') in June. Spawning is believed to occur in the immediate area or at the mouth of the Chagrin River (Aquat. Ecol. Assoc. 1976b; Environ. Resour. Assoc. 1978).

O-3

Perry Power Plant (41°48', 81°09'). In 1974, logperch were more abundant than other percid larvae in the vicinity of the plant from early May to mid-July; peak abundance occurred in late June at a water temperature of about 59°F. Prolarvae were collected in July, indicating a prolonged spawning season in the area (NUS 1975).

Arcola Creek (41°51', 81°00'). Ripe adults were collected on the beach just west of the mouth of the creek over gravel and stones of 4-6 in. diameter (White, pers. comm. 1979).

Ashtabula (41°55', 80°47'). Logperch spawn in Ashtabula Harbor (41°55', 80°47') in 5-15 ft of water; larvae were collected in the harbor (White, pers. comm. 1979). In 1977-78, about 2% of all larvae entrained at the Ashtabula power plants (41°55', 80°46') during mid-April to late June were logperch (Applied Biology 1979e).

Conneaut (41°58', 80°33'). Logperch enter the Conneaut River (41°58', 80°33') and Turkey Creek (41°58', 80°32') to spawn. In 1977, larvae were collected from both tributaries in May and June. In late August, fry were collected on the bottom, 1/2 mi offshore from Turkey Creek. Larvae were also collected inshore and offshore between Conneaut and Raccoon Creek (41°59', 80°29'), and in Conneaut Harbor (41°58', 80°33') (Aquat. Ecol. Assoc. 1978c). Logperch spawn in Conneaut Harbor in 5-15 ft of water. Spawning takes place on the eastern and western outer edge of the harbor as well as inside the harbor itself. Ripe adults were collected on the beach in the same area where johnny darters and longnose dace were taken; logperch usually spawned over slightly larger rock than did the other two species. Logperch fry were also collected here (White, pers. comm. 1979).

Pennsylvania

In the spring, large spawning runs enter tributaries that are not blocked by falls. Spawning occurs in the warm, shallow pool areas not too far upstream in 1 ft or less of water probably over vegetation. Young-of-the-year are found in late May and early June in the streams; they apparently move downstream to the lake, where they are found in 36 to 48 ft of water in August. The following are spawning and nursery areas.

Raccoon Creek (41°59', 80°29'). Larvae were collected in the creek in June (Aquat. Ecol. Assoc. 1978c).

Crooked Creek (42°00', 80°26'). In 1975, many logperch were seen spawning in the creek over sand and gravel in swift water in late April; spawning usually occurred less than 33 ft upstream from the creek mouth but did occur as far as 4,000 ft upstream. Ripe adults were collected as late as May 30, and larvae were collected in Lake Erie in June and July (Cooper 1978).

Elk Creek (42°01', 80°22'). In 1974, the abundance of adults increased in the riffle areas from early May to early June and decreased sharply after June (GPU Serv. Corp. 1979). Many larvae were collected off the creek mouth in June and July (USACE, undated b; GPU Serv. Corp. 1979).

Trout Run (42°03', 80°16'), Walnut Creek (42°04', 80°14'), Presque Isle Bay (42°08', 80°07'), Fourmile Creek (42°09', 80°02'), Sixmile Creek (42°11', 79°59'), Eightmile Creek (42°11', 79°58'), and Twelvemile Creek (42°13', 79°55') (Kenyon, pers. comm. 1979).

New York

In eastern Lake Erie, logperch ascend streams to spawn on riffles until late June (Greeley 1929).

Van Buren Bay (42°27', 79°25'). In 1975, logperch was one of the most abundant species of larvae in waters off Van Buren Bay. Both prolarvae and postlarvae were collected from May to August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1976, eggs were entrained at the Dunkirk Steam Station (42°30', 79°21') from early to late June, prolarvae from late May to July, and postlarvae from June to August. Logperch was one of the most abundant species entrained (Tex. Instrum. 1977e). Prolarvae were abundant in the harbor from May to August and postlarvae from June to August; it was assumed that spawning occurred in or near the harbor area (Tex. Instrum. 1977d).

Eagle Bay (42°32', 79°14'). In waters off Eagle Bay, logperch was one of the most abundant species of larvae. Both prolarvae and postlarvae were collected during May to August (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03'); YOY were present in the area from June 7 through July 26 (Teleki 1976).

CHANNEL DARTER

Channel darters ascend Lake Erie tributaries to spawn (Greeley 1929); they also spawn on bouldery lake shoals in the western basin (Langlois 1954).

Michigan

Fermi Power Plant (41°57', 83°15'). In 1976, small numbers of late postlarvae were collected offshore from the plant in mid-July (Detroit Edison 1978).

Ohio

O-1

Middle Bass Island (41°41', 82°49'). In 1949, breeding adults were collected at Lutz's Point (location unknown) in late June (Garrett 1949, as cited by Langlois 1954).

New York

Eighteenmile Creek (42°43', 78°58'). Ripe males were found in mid-July on riffles 1/4 mi upstream from the creek mouth (Greeley 1929).

SAUGER

Saugers were virtually extinct in Lake Erie but have recently been reintroduced (Rawson and Scholl 1978b; White, pers. comm. 1979). Historically, saugers in the western basin moved inshore and spawned in April and May, often before ice-breakup (Doan 1941, 1942b; Moore 1894; Rawson and Scholl 1972b), and large catches were made at this time (MSBFC 1887). Saugers spawned along shore at the extreme western end of Lake Erie and in other shallow places in the western basin (Rathbun and Wakeham 1897). Runs entered tributaries, where spawning occurred over rocky and sandy bottom; spawning also occurred in the inshore waters along the south shore, particularly near Maumee Bay (Fish 1929; Regier et al. 1969). Eggs were collected from the bottom in shallow water along the south and west shores of the western basin (Wickliff 1928a). In 1928, fry appeared to be concentrated in May to August along the southwest and south shores from Monroe (41°55', 83°24') and Lakeside (location unknown), Michigan, east across the entrance to Maumee Bay (41°43', 83°25') to Marblehead (41°32', 82°43') (Wickliff 1928a).

Michigan

Swan Creek (41°58', 83°15')--Stony Point (41°56', 83°16'). Since 1921, saugers have spawned in an area along the shore over mud bottom out to about the 20 ft depth contour (Organ et al. 1978).

Woodchuck Creek (41°51', 83°24'). Since 1921, spawning has occurred in an area (extending from 41°51', 83°20' to 41°50', 83°19') about 3-4 mi off the creek over gravel in 14-20 ft of water (Organ et al. 1978).

Otter Creek (41°51', 83°24'). Since 1921, saugers have spawned in an area (41°50', 83°21') 3-4 mi off the mouth of the creek over clay in about 14 ft of water (Organ et al. 1978).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Historically, a very large sauger fishery existed at Toledo (41°40', 83°30'); saugers were the major catch in the bay until April 15 (Moore 1894). Eggs were collected from pondweeds inside the bay (Wickliff 1928a). Saugers presently migrate into the Maumee River (41°41', 83°28') to spawn in March and April (Lake Erie Fish. Unit Staff 1979; Rawson, pers. comm. 1979; Rawson and Scholl 1978a,b). Concentrations of mature adults are found in the bay in May (USACE 1976c) and on cobble and boulder riffles in the river (Rawson and Scholl 1978a,b). In 1977, prolarvae and postlarvae were found in small numbers in early May and early June at the entrance to the bay, around Cedar Point (41°42', 83°20') and between the point and the shipping channel (41°43', 83°22'). In 1976, one larva was collected on the riffles above Perrysburg on April 8 (Herdendorf 1977; Herdendorf and Cooper 1976; Patterson 1979a).

Locust Point (41°36', 83°05'). Historically, saugers were caught until April 15 in the area from (Upper) Cedar Point (41°42', 83°20') to Locust Point (Moore 1894). Mature saugers are presently collected off Locust Point (Rawson and Scholl 1978a,b).

Island Region (41°40', 82°45'). In the spring, fishermen first caught migrating adults south of Green Island (41°39', 82°52'), then between the islands, and then in the deep hole (at approximately 41°37', 82°38') northeast of Kelleys Island. Until 1953, saugers either spawned en route to or in the deep hole (Trautman, pers. comm. 1979).

Sandusky Bay (41°29', 82°46'). Saugers presently migrate from the western basin into the Sandusky River (41°27', 82°59') in March and April (Lake Erie Fish. Unit Staff 1979; Rawson, pers. comm. 1979; Rawson and Scholl 1978a,b; Wolfert, pers. comm. 1979) to spawn on the riffles at Fremont (FWS 1979d). In 1976-77, mature adults were collected in the bay and the river along shale bedrock ridges and over sand and gravel substrate from March 15 to May 1; running-ripe females were caught on April 12-15 (Rawson and Scholl 1978a,b). Until the 1950s, there was also a lake spawning population in the Sandusky area (Wolfert, pers. comm. 1979).

O-2

Lorain (41°28', 82°11'). Larvae were collected in very small numbers in Lorain Harbor (41°28', 82°11') (Geo-Marine 1978).

Chagrin River (41°41', 81°26'). A few young-of-the-year (YOY) were collected off the river mouth (White, pers. comm. 1979).

O-3

Ashtabula River (41°55', 80°47'). A few YOY have been collected off the river (White, pers. comm. 1979). Larvae were entrained during April to June at the Ashtabula power plants (41°55', 80°46') (Applied Biology 1979e).

Conneaut River (41°58', 80°33'). In 1979, a few larvae were collected off the Conneaut River (White, pers. comm. 1980).

Ontario

OE-4

Inner Bay (42°37', 80°22'). Saugers historically spawned during April in the lower waters of Big Creek (42°36', 80°27') and occasionally in the bay outside the mouth of Big Creek and in other tributaries leading into the bay (Kerr and Kerr 1860-1898; Whillans 1977).

BLUE PIKE

The blue pike was once an abundant and commercially important fish in the lower Great Lakes. Although there was disagreement about the taxonomic differences between blue pike and walleye, the blue pike was usually considered a subspecies. Populations of blue pike were mainly confined to central and eastern Lake Erie, the Niagara River, and western and southern Lake Ontario. The Lake Erie fishery for blue pike collapsed in 1958, and the last confirmed specimen in the lower Great Lakes was collected in 1965 (Blue Pike Recovery Team 1975; Parsons 1967).

The blue pike generally spawned on gravel bars in Lake Erie, in about 20-40 ft of water, in May and June; it was found in water shallower than 36 ft only during the spawning season (Deason 1933; Doan 1942; Scott 1967; Slastenenko 1957; Van Oosten and Hile 1949; Wolfert, pers. comm. 1979). In the 1890s, the best runs of blue pike along the Pennsylvania shoreline occurred in May. Blue pike appeared in catches east of Sandusky and Kelleys Island in April; they were most abundant there in the latter part of May and in June (Moore 1894; Rathbun and Wakeham 1897). Until the 1960s, blue pike spawned on gravel bars in the central basin in 20-40 ft of water; primarily in an area from Lorain (41°28', 82°11') to Conneaut (41°58', 80°33') (White, pers. comm. 1979). Until about 1965, eggs were collected from ripe blue pike in an area extending east from Sandusky (41°27', 82°42') through the basin, about 5-10 mi from shore (Reynolds, pers. comm. 1979).

Although blue pike have been reported to spawn only in the central and eastern basins (Trautman, pers. comm. 1979; White, pers. comm. 1979; Wolfert, pers. comm. 1979), spawn from ripe fish was collected in the western basin (Ont. Game Fish 1939, 1940).

Michigan

Stony Point (41°56', 83°16'). Blue pike spawned between Point aux Peaux (41°57', 83°15') and Stony Point in an area extending from 41°58', 83°13' to 41°55', 83°13' and from the shoreline offshore for 2-3 mi to the 20 ft depth contour (Organ et al. 1978).

Pennsylvania

Spawn was collected from ripe fish in Pennsylvania waters (Bean 1913). In 1953, gravid walleyes and blue pike were collected together in gill nets on the bottom in 50 ft of water at a water temperature of 48°F in May. It was concluded that blue pike spawned at about the same temperature in Lake Erie and Lake Ontario. In Lake Erie, blue pike usually spawned about 1 month later than walleyes, because the deeper waters of the eastern basin where blue pike spawned warmed more slowly in spring than did the waters where walleyes spawned (Blue Pike Recovery Team 1975).

Long Point Bar (Northwest Sand Bar) 42°19', 80°20'. In 1960 and 1961, small numbers of eggs were found in Pennsylvania waters at the end of Long Point Bar (GLFC 1960, 1961).

Erie (42°07', 80°05'). In the 1950s and 1960s, ripe blue pike were collected in 60 ft of water off Erie (at approximately 42°12', 80°15' and 42°17', 80°00') in April and May (Larsen, pers. comm. 1979).

New York

In the New York waters, blue pike migrated to breeding areas and spawned somewhat later than walleyes (N.Y. Dep. Conserv. 1921).

Ontario

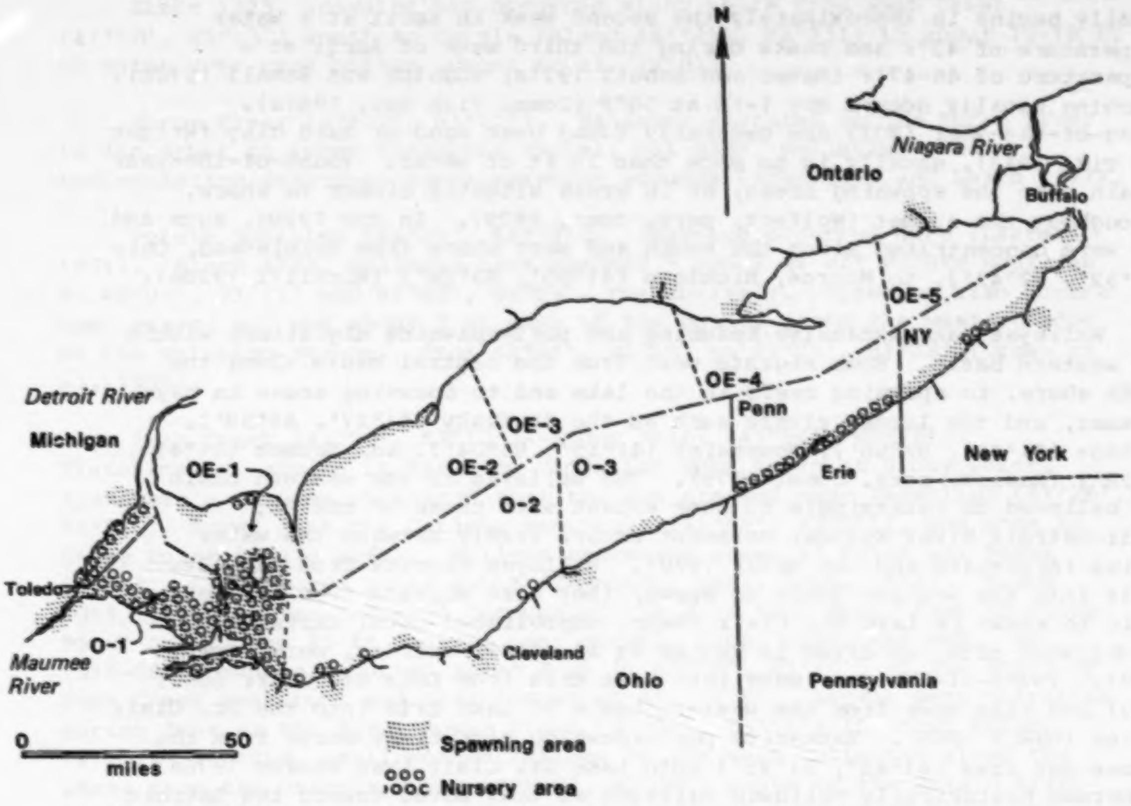
OE-4

Long Point Bay (42°40', 80°10'). Historically, spawning occurred in the lower reaches of Big Creek (42°36', 80°27') and occasionally in Inner Bay (42°37', 80°22') outside the creek mouth (Kerr and Kerr 1860-1898; Whillans 1977). This stock of blue pike disappeared about 1960 (Whillans 1977).

OE-5

Lowbanks (42°52', 79°27'). In 1910, a spawning run occurred in the vicinity (Ont. Game Fish 1911).

WALLEYE


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
New York
OE-1
OE-2
O-3
Erie
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In Lake Erie, walleyes spawn in late March to mid-May; spawning peaks in late April or early May (NYDEC 1977a; Rathbun and Wakeham 1897; Schuter and Koonce 1977; Wickliff 1957), when the ice breaks up and the water temperature approaches 45°F (Fish 1932; FWS 1945; Parsons 1972; Van Oosten and Hile 1949). Spawning occurs near reefs, in streams, bays, and along most of the shoreline. Walleyes exhibit a homing tendency; each reef may support its own discrete spawning population (Lake Erie Res. Unit Staff 1978; Wolfert, pers. comm. 1979). Historically, spawn was collected in Lake Erie in March and April (Langlois 1945b). Spawning success is more affected by rate and regularity of water warming in spring than by water level. If slow warming occurs, the incubation period is lengthened, and eggs are more vulnerable to the adverse effects of storms, siltation, etc. (Busch et al. 1975; Harris and Eschmeyer 1975; Muth 1977; Scott et al. 1978a; Tait 1973). Spawning grounds on reefs may not be used if wind-induced wave action is too strong (Leach et al. 1977).

The western basin of Lake Erie is the major spawning and nursery area for walleyes in Lake Erie (Nepszy 1977; Parsons 1971; Schneider and Leach 1979; Wolfert 1963). Spawning occurs in tributaries, on reefs, and along most of the shoreline (CLEAR 1978; Frank et al. 1978; Rathbun and Wakeham

1897; Wapora 1977a). Historically, spawn was collected in the western end of the lake in April (MSBFC 1895). Spawning has begun as early as March 31, at a water temperature of 39°F, and as late as April 19. Spawning usually begins in approximately the second week in April at a water temperature of 42°F and peaks during the third week of April at a temperature of 46-47°F (Baker and Scholl 1971a; Rudolph and Scholl 1970b). Hatching usually occurs May 1-15 at 50°F (Comm. Fish Rev. 1961a). Young-of-the-year (YOY) are generally found over sand or hard clay (Wright and Tidd 1933), usually in no more than 20 ft of water. Young-of-the-year remain near the spawning areas, or in areas slightly closer to shore, throughout the summer (Wolfert, pers. comm. 1979). In the 1920s, eggs and fry were concentrated along the south and west shore from Marblehead, Ohio (41°32', 82°43'), to Monroe, Michigan (41°55', 83°24') (Wickliff 1928a).

Walleyes make extensive spawning and post-spawning migrations within the western basin. Some migrate west from the central basin along the south shore, to spawning reefs in the lake and to spawning areas in bays, streams, and the larger rivers such as the Sandusky (41°27', 82°59'), Portage (41°31', 82°56'), Toussaint (41°35', 83°04'), and Maumee (41°41', 83°28') (Rawson, pers. comm. 1979). The walleyes in the western basin are believed to intermingle to some extent with those of the St. Clair-Detroit River System; movement occurs freely between the water bodies (Applegate and Van Meter 1970). Walleyes migrate from Lake St. Clair into the western basin to spawn; they also migrate from the western basin to spawn in Lake St. Clair (Manz, unpublished data; Christie, unpublished data, as cited in Regier et al. 1969; Wolfert, pers. comm. 1979). Young-of-the-year move into Lake Erie from Lake St. Clair (USDI 1967) and also move from the western basin of Lake Erie into the St. Clair System (USBCF 1966). Extensive post-spawning migrations occur from the Maumee Bay area (41°43', 83°25') into Lake St. Clair (Van Vooren 1976a). Fishermen historically followed walleyes as they moved toward the Detroit River in the fall. Tagging recoveries indicate a post-spawning migration northward to the Canadian reef area (41°48', 82°49') then west to the Detroit River (42°03', 83°08') and into Lake St. Clair and southern Lake Huron (Julien 1967). A spawning migration occurs from southern Lake Huron and Lake St. Clair to the mouth of the Detroit River, and then to spawning grounds on the western and southern shore of Lake Erie (Baker 1967d, 1969a; Baker and Scholl 1969; Van Vooren 1978). In 1979, tagging recoveries indicated that a post-spawning migration also occurs from the Michigan waters of the western basin to Pennsylvania waters (Kenyon, pers. comm. 1979).

Walleyes spawn along the shoreline throughout the entire eastern basin from the Ohio-Pennsylvania border to Little Sister Creek (42°40', 79°04'). The spawning grounds are rocky and usually in water 4-6 ft deep. There are few reefs or shoals in this area, and spawning takes place wherever rocky areas exist. This area has probably been used for spawning since the early 1950s, based on the collection of ripe fish (Wolfert, pers. comm. 1979).

Michigan

Since 1925, spawning has occurred along shore from Swan Creek (41°58', 83°15') south to Turtle Island (41°45', 83°23') in about 12-18 ft of water over rock bottom (Organ et al. 1978).

Huron River (42°02', 83°12'). Walleyes migrated up the Huron River to Ann Arbor to spawn (Langlois 1945a), but dams, pollution, and sedimentation destroyed these spawning grounds (Schneider and Leach 1977).

Pointe Mouillee (42°01', 83°12'). Spawning occurred here (Laarman 1971). Since 1921, walleyes have spawned 1 and 3 mi off Pointe Mouillee at 42°01', 83°11' and 42°00', 83°09', respectively. Spawning also occurs over gravel and mud about 2 mi east of the point, along the western edge of the shipping channel, from 42°01', 83°09' to 42°03', 83°08' (Organ et al. 1978).

Swan Creek (41°58', 83°15')--Stony Point (41°56', 83°16'). Historically, adults in spawning condition were taken at Stony Point. Fishermen's catches indicated that the run started near Vermilion (41°26', 82°22'), moved past the Catawba peninsula (41°35', 82°51'), and then to Stony Point (Hosko 1967). Walleye presently spawn at Point aux Peaux (41°57', 83°15') and Stony Point (Reynolds, pers. comm. 1979). Since 1911, spawning has occurred throughout the area from Swan Creek to Stony Point out to the 20 ft contour over gravel, rock, clay, and mud. In 1935-68, spawning occurred about 4 mi E (41°58', 83°10') of the mouth of Swan Creek over rock and clay (Organ et al. 1978). Larvae were entrained during June at the Fermi Power Plant (41°57', 83°15') (Detroit Edison 1976g). In 1959, small concentrations of YOY were collected along the shore from the Detroit River (42°03', 83°08') south to the Raisin River (41°53', 83°20'); YOY were most abundant over sand in 10-19 ft of water (Parsons 1972).

Monroe (41°55', 83°24'). In the 1950s, spawn was collected by commercial fishermen at Monroe (Westerman 1954). Spawning occurs in an area (41°52', 83°21') just off the mouth of Plum Creek in up to 6 ft of water (Reynolds, pers. comm. 1979); until the 1950s, spawning also occurred over rock in an area (41°52', 83°17') about 3 mi from the creek mouth, at depths to 18 ft (Organ et al. 1978). Walleyes also spawn on the reefs along the shipping channel (41°53', 83°20'--41°53', 83°17') at the mouth of the Raisin River (Reynolds, pers. comm. 1979). At the Monroe Power Plant (41°53', 83°21'), eggs and larvae were entrained in early May and early June (Detroit Edison 1976h). Young-of-the-year were relatively abundant off Monroe (MDNR 1970-76); they appeared to be concentrated over hard clay, sand and gravel in 10 ft of water in an area (41°52', 83°20') off the mouth of Plum Creek (Rawson, pers. comm. 1979).

Otter Creek (41°51', 83°24'). Since 1921, spawning has occurred in an area (41°50', 83°21') about 3 mi offshore over clay (Organ et al. 1978).

Muddy Creek (41°50', 83°25'). Walleyes spawned (no dates given) in an area (41°49', 83°25') off the mouth of the creek in 1-7 ft of water (Reynolds, pers. comm. 1979).

Whiting Power Plant (41°47', 83°27'). Maximum impingement occurs in May, and most of the fish are adults that had moved to the shallows to spawn. Larvae were collected in North Maumee Bay and entrained at the plant in May and June (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25'). Historically, the bay area was the most productive walleye spawning ground in Lake Erie; walleyes were the most abundant fish taken in the bay beginning around mid-April (Moore 1894; Rathbun and Wakeham 1897). Spawning migrations were recorded as early as 1885, and until 1950, spawning occurred as far as 30 mi upstream at Grand Rapids ("Les Grand Rapides") (Langlois 1945a; Trautman 1957). During the late 1800s, spawn was collected in and near the bay in April (MSBFC 1897, 1899). Walleyes migrate through Maumee Bay to spawn on the rocky areas of the Maumee River (41°41', 83°28') in March and April; some migrate as far upstream as the rapids at Perrysburg (CLEAR 1977, 1978a; Lake Erie Res. Unit Staff 1977, 1978; Langlois 1941, 1944, 1945a; Nepszy 1977; Pinsak and Meyer 1976; ODNR 1976; Rawson, pers. comm. 1979; Rawson and Scholl 1978b; Regier et al. 1969; Snyder 1978; Trautman 1957, pers. comm. 1979; Van Vooren 1976a,b, 1978; Wapora 1977b, 1978a,b; Wolfert, pers. comm. 1979). Temperatures in the river during spawning range from 37 to 64°F (Van Vooren 1978). Tagging studies have shown that the spawning population exhibits homing tendencies (Van Vooren 1976a,b; Wolfert, pers. comm. 1979). Rapidly warming water temperatures of the tributaries may decrease the duration of spawning migrations (Lake Erie Res. Unit Staff 1978). Dams, pollution and sedimentation have severely damaged the spawning grounds in the river (Parsons 1972; Schneider and Leach 1977). In addition to serving as a migration pathway for walleye stocks that spawn in the river (Fraleigh and Tramer 1974; Frank et al. 1978; USACE 1976; Wapora 1977c), Maumee Bay also contains a number of spawning grounds. Collections of eggs on the rock shoals in the eastern part of the bay (at 41°42', 83°25'; 41°42', 83°24'; and 41°44', 83°20') and around the shoals, spoils area, and dredge islands along the shipping channel in the central bay (from 41°42', 83°27' to 41°47', 83°19') indicated that spawning occurs in water 1-16 ft deep at temperatures of 42-61°F, from late March to late April (Fraleigh and Frank, undated a,b; Frank et al. 1978; Organ et al. 1978; Reynolds, pers. comm. 1979). Since 1900, or earlier, spawning occurred offshore at a site (41°42', 83°25') southeast of the spoils area; this spawning area may have been destroyed by power plant discharges. Since 1931, spawning has occurred on the dredge spoils areas; the spoils site (41°42', 83°27') at the mouth of the Maumee River was filled in about 1960 and no longer supports spawning (Reynolds, pers. comm. 1979). The ODNR believes that silt deposits prevent walleyes from spawning in the bay (Fraleigh and Tramer 1974; USACE

1976). Limited early season sampling of larvae has indicated that Maumee Bay is an important spawning area (Herdendorf 1978; Hendendorf and Cooper 1975, 1976).

The bay is also a nursery area (USACE 1976). In 1975-77, larvae were collected in the bay from late April to June. Downstream movement of larvae from the Maumee River occurs as the yolk-sac is being absorbed (Snyder 1978).

Ward Canal (41°39', 83°14'). In 1976, fairly high densities of prolarvae and postlarvae were found just off the canal in early May (Patterson 1979a).

Crane Creek (41°38', 83°12'). Young-of-the-year were abundant near Crane Creek (Baker and Scholl 1971c; Hair and Scholl 1971; Rudolph and Scholl 1970; USNRC 1973, 1975).

Locust Point (41°36', 83°05') and Locust Point Reef Complex (41°39', 83°02'). This entire reef complex including West Sister Island (41°44', 83°06') and Locust Point (41°39', 83°04'), Niagara (41°40', 82°58'), Crib (41°39', 83°00'), and Toussaint (41°38', 83°01') reefs is a major spawning area (Ayers and Anderson 1969; Ayers et al. 1970; Baker and Scholl 1971a; Regier et al, 1969; Rudolph and Scholl 1970b). Eggs and fry were collected throughout the area (Hohn 1966; Regier et al. 1969). Sampling during the early 1960s showed that the smaller fry, about 0.2-0.3 in. long, were collected among the reefs in this area. Later in the season, the larger fry about 0.4-0.5 in. long were found about 4 mi SW of the reef area, inshore near Locust Point, in 6-10 ft of water over mud and sand (Manz 1963).

West Sister Island (41°44', 83°06'). The area from the island south to Locust Point is a major spawning area; spawning occurs at water temperatures of about 43-59°F, and many eggs have been collected in April and early May (Keller 1964b; Keller and Manz 1960, 1963).

Turtle Reef (41°40', 83°06'). Eggs were collected here (Baker 1964).

Locust Point Reef (41°39', 83°04'). This is a major spawning area; many eggs have been collected from the reef (Baker 1964, 1967d; Manz 1960; Rudolph and Scholl 1970b).

Niagara Reef (41°40', 82°58'). This is a major spawning area where eggs and many larvae have been collected. Spawning begins anytime from late March to mid-April at water temperatures of 36-46°F and usually peaks about the third week of April at a water temperature of 46°F (Baker 1964, 1966b, 1967d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Heniken 1977; Manz 1960; Rudolph and Scholl 1970b; Wolfert, pers. comm. 1979).

Crib Reef (41°39', 83°00'). This is a major spawning area where eggs have been collected. Spawning begins anytime from late March to mid-April at water temperatures of about 36-46°F and peaks about the third week of April at water temperatures of about 41-53°F (Baker 1964, 1966b, 1967b, 1967d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Lake Erie Fish. Unit Staff 1977, 1978; Manz 1960; Rudolph and Scholl 1970b; Van Vooren 1978; Wolfert, pers. comm. 1979).

Toussaint Reef (41°38', 83°01'). This is a major spawning area where eggs have been collected and spawning has been observed in 1-16 ft of water. Spawning begins any time from late March to mid-April at 36-46°F and peaks about the third week of April at water temperatures of about 41-53°F. Peak abundance of adults on the reef has occurred on April 14 at 41°F (Baker 1964, 1966b, 1967b,d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Manz 1960; Reynolds, pers. comm. 1979; Rudolph and Scholl 1970b; Van Vooren 1976a,b; Van Vooren and Davies 1974).

Locust Point (41°36', 83°05'). Walleye eggs are abundant off Locust Point over rock bottom (Heniken 1977). Spawning occurs in the Sand Beach area (41°37', 83°05') just off Locust Point, in 9-12 ft of water over gravel and rock (Reynolds, pers. comm. 1979). In 1976-78, prolarvae and postlarvae were found in fairly high densities in May just off shore over sand and rock (Heniken 1977; Patterson 1979a; Reutter 1979b, 1979c). A few larvae were found on either side of Locust Point, west to Cedar Point (41°42', 83°20') and east to Catawba Island (41°35', 82°51'); these could have been carried off the spawning reefs by southerly currents (Heniken 1977). In 1959, YOY were abundant along the shore from Sandusky Bay west to Cedar Point; they tended to concentrate over sand bottom in water 10-19 ft deep and none were found in water deeper than 29 ft (Parsons 1972). Recent collections of YOY indicate that the sandy shoreline areas from Locust Point east to Catawba Island and west to Cedar Point may be nursery areas (Wolfert, pers. comm. 1979). Historically, adults were caught in the area from Locust Point to Cedar Point only during April (Moore 1894).

Toussaint River (41°35', 83°04'). Spawning occurs off the mouth of the river (at 41°36', 83°04') (Reynolds, pers. comm. 1979).

Portage River (41°31', 82°56'). Spawning runs enter the river and proceed upstream to rock and gravel areas, where spawning occurs in water 1-16 ft deep at temperatures of 43-55°F (Lake Erie Fish. Res. Unit Staff 1977; Langlois 1965; Rawson, pers. comm. 1979; Reynolds, pers. comm. 1979). Spawning occurs at Port Clinton (41°31', 82°56') (Laarman 1971). In 1966, ripe females were collected near Port Clinton in April (Wolfert 1969).

Sugar Bluff (possibly Sugar Rock; 41°34', 82°51'), Mouse Island (41°35', 82°50'), and Moore's Point (location unknown). Historically, spawning occurred on these extensive grounds (Goode 1884).

West Harbor (41°34', 82°49'). Historically, this was an extensive spawning ground (Goode 1884). In the 1960s, eggs were collected on reefs (41°34', 82°48'; 41°35', 82°49'; and 41°35', 82°48') just offshore (Baker 1964).

East Harbor (41°32', 82°47'). Historically, this was a spawning ground (Goode 1884). In 1977, 40% of the YOY collected in Ohio waters were captured in East Harbor (Van Vooren et al. 1978); they were also abundant during 1969 and 1970 (Baker and Scholl 1971c).

Spit Island (location unknown). Historically, this was an extensive spawning ground (Goode 1884).

Bass Islands (41°41', 82°49'). Historically, spawning occurred over extensive grounds at Put-In-Bay (41°39', 82°49'), North Bass (41°43', 82°49'), and Middle Bass (41°41', 82°49') Islands (Goode 1884). The islands and associated reefs have been acknowledged as major spawning sites based on collections in 1943-62 of adults, eggs, and fry (Baker and Manz, as cited in Regier et al. 1969; Baker and Scholl 1971a; Parsons 1970). In 1961-62, fry were collected in May near spawning grounds on the west side of the Bass Islands (Hohn 1966). Egg collection around the islands indicate that most spawning occurs over rocky substrate in less than 15 ft of water (Baker and Scholl 1971a; Heniken 1977; Keller 1964b; Keller and Manz 1963; Manz 1960; Regier et al. 1969). Eggs were collected from the Bass Islands-Kelleys Island Shoal (41°38', 82°39') complex and associated shoals from April to early May at water temperatures of 43-59°F (Keller 1964b). West Island Shoal (West Reef; 41°43', 82°51'), west of North Bass Island, was a major egg collecting site (Baker 1964, 1966b, 1967d, 1969a; Baker and Scholl 1971a; Manz 1960; Rudolph and Scholl 1970b). A few fry and YOY were collected from the islands area (Baker 1965; Hohn 1966; Parker 1964; Parsons 1972; Selden and Van Meter 1960).

Starve Island Reef (41°37', 82°49'). This is a major spawning area (Baker 1964, 1966, 1967b, 1969a; Baker and Scholl 1969, 1971a; Manz 1960; Rudolph and Scholl 1970b). A number of fry 3 in. long were collected at a depth of 26 ft at an unidentified location between Starve Island (41°38', 82°49') and Middle Island (41°41', 82°41') (Langlois 1954).

Kelleys Island Shoal (41°38', 82°39'). This is a major spawning reef (Busch et al. 1975; Goode 1884; Rudolph and Scholl 1970b; Wolfert, pers. comm. 1979; Van Vooren 1976a,b, 1978). Spawning adults were collected here (Wolfert et al. 1975), and spawning was observed over rubble and boulder bottom at a depth of 5-6 ft in late April at a water temperature of 48°F (Baker 1967b). Spawning on the shoal begins at a water temperature of 39°F and peaks at 45°F (Wolfert et al. 1975). Eggs have often been collected from the shoal (Baker 1964, 1966b, 1967b,d, 1969a; Baker and Scholl 1969, 1971a; Busch et al. 1975; Keller 1964b; Keller and Manz 1963; Manz 1960; Rudolph and Scholl 1970b).

Gull Island Shoal (41°40', 82°41'). Egg collections indicate that this is a major spawning area (Baker 1964, 1966b, 1967d, 1969a; Manz 1960; Rudolph and Scholl 1970b).

Marblehead Peninsula (41°32', 82°43'). Historically, this was an extensive spawning ground (Goode 1884). Sampling in 1943-62 also showed that the area around Marblehead Peninsula is a spawning and nursery ground (Parsons 1970).

Sandusky Bay (41°29', 82°46'). Walleyes enter the bay and the Sandusky River (41°27', 82°59') to spawn in March to May; some spawning occurs as far upstream as Fremont (Baker 1967d; Baker and Scholl 1969, 1971a; Chapman 1955; CLEAR 1977; FWS 1979d; Griswold et al. 1978; Lake Erie Res. Unit Staff 1978; Langlois 1945a; Rawson, pers. comm. 1979; Rawson and Scholl 1978b; Regier et al. 1969; Reynolds, pers. comm. 1979; Wapora 1977; Wolfert, pers. comm. 1979). Historically, walleyes were so abundant at the Sandusky River rapids in the spring that one could not cross the rapids without stepping on them (Keeler 1904). Eggs for hatchery use were collected in the Sandusky area on about April 1 (Howe 1907). Presently, the river is a minor spawning area compared to the reef areas (Applegate and Van Meter 1970; USBCF 1966; USDI 1967), and walleye are not very common in the bay except during the spawning run (Van Meter 1963). Spawning also occurs in the bay itself (FWS 1979d; Laarman 1971; Regier et al. 1969), and a spawning ground historically existed at Cedar Point (41°29', 82°41') (Goode 1884). Water temperatures during the spawning season range from 37-64°F (Van Vooren 1978). Tagging studies have shown that the spawning population in the Sandusky River exhibits a homing tendency and may be discrete from the populations of the reefs (Van Vooren 1976a,b, 1978; Wolfert, pers. comm. 1979). Rapidly warming temperatures may decrease the duration of spawning migrations (Lake Erie Res. Unit Staff 1978). Pollution, dams, and siltation have damaged the spawning areas in the river (Busch et al. 1975; Schneider and Leach 1977; USDI 1967).

Young-of-the-year were collected in the bay and at the entrance to the bay at Cedar Point in May to October (Baker 1966b; Baker and Scholl 1971c; Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Keller 1964a; Rudolph and Scholl 1970a; Selden and Van Meter 1960; Van Vooren and Davies 1974; Van Vooren et al. 1978); YOY were most abundant in Sandusky Bay and adjacent sites along the shore at Cedar Point (Van Vooren et al. 1977). In 1974, 48% of the YOY captured in Ohio waters were taken at Cedar Point (Van Vooren 1975). Catches of YOY indicate that the shoreline from Cedar Point east to Old Woman Creek (41°23', 82°31') is a nursery area (Wolfert, pers. comm. 1979).

0-2

Huron River (41°24', 82°33'). A spawning migration enters the river (FWS 1979d).

Vermilion (41°26', 82°22'). Historically, walleyes entered the Vermilion river (41°26', 82°22,) and proceeded at least 30 mi upstream to spawn above Wakeman (Langlois 1945a). In 1960, walleye eggs were collected just off Vermilion (Manz 1960). In 1973-77, YOY were abundant at Vermilion (Van Vooren et al. 1978).

Beaver Creek (41°26', 82°15'). In 1979, prolarvae were found out to the 36 ft depth contour in late May, postlarvae in mid-June, and juveniles in early July. A few YOY were captured at Oak Point Beach near the creek mouth in mid-June and in late August (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). Ripe adults were collected over gravel in about 10 ft of water in an area (41°28', 82°12') just west of Lorain; this may be a spawning area (White, pers. comm. 1979). In 1973-77, YOY were abundant at Lorain (Van Vooren et al. 1978).

Avon Lake Power Plant (41°30', 82°03'). Ripe adults were collected nearshore (41°30', 82°04') in about 10 ft of water over a gravel bottom (White, pers. comm. 1979). In 1975, walleyes were abundant in June near the power plant; these may have been mature adults seeking suitable spawning sites (Aquat. Ecol. Assoc. 1976c).

Cuyahoga River (41°30', 81°43'). Spawning migrations entered the river and moved upstream to the rapids above Akron, but dams, pollution, and sedimentation destroyed these spawning areas (Langlois 1945a; Schneider and Leach 1977). Presently, walleyes spawn in about 10 ft of water on a gravel beach at Lakewood (41°30', 81°47'), just west of the river mouth (White, pers. comm. 1979).

Chagrin River (41°41', 81°26'). Larvae were collected in water 25 ft deep off the river mouth (White, pers. comm. 1979).

O-3

Grand River (41°46', 81°17'). Historically, spawning migrations entered the river, but dams, pollution, and sedimentation have destroyed the spawning areas (GLBC 1975; Langlois 1945a; Schneider and Leach 1977). Walleyes in the river are believed to be remnants of the run that existed before a dam was built at the river mouth (GLBC 1975).

Perry Power Plant (41°48', 81°09'). In 1974, one prolarva was collected here in early May (NUS 1975).

Ashtabula (41°55', 80°47'). Adults in spawning condition were collected off the Ashtabula power plants (41°55', 80°46') just east of the Ashtabula River (Aquat. Ecol. Assoc. 1976).

Pennsylvania

Walleyes spawn along the entire Pennsylvania shoreline over rock in water approximately 4-12 ft deep. Ripe males and females were collected in May at the mouths of creeks flowing into Lake Erie; YOY were taken in August, on rocky beach areas, usually within the 36 ft depth contour. After spawning, approximately 10% of the walleyes on the east side of Presque Isle peninsula migrate to areas from Barcelona (42°20', 79°36') to Buffalo (42°55', 78°53') (Kenyon, pers. comm. 1979; Moore 1894).

Raccoon Creek (41°59', 80°29'). Walleyes spawn on gravel bars off the mouth of the creek and east to Crooked Creek (42°00', 80°26') (White, pers. comm. 1979).

Presque Isle Bay (42°08', 80°07'). Ripe walleyes were collected in the inner portion of the bay (Kenyon, pers. comm. 1979).

New York

Major nursery areas exist along the New York shore (Schneider and Leach 1979).

Barcelona (42°20', 79°36'). There is a major spawning reef near Barcelona (Harris and Eschmeyer 1975). In 1966, ripe walleyes were collected here in April, and in 1968, spawning walleyes were captured offshore in May (Wolfert 1969; Wolfert and Van Meter 1978). In June and July, soon after spawning at Barcelona, walleyes migrate along the south shore to Buffalo (42°55', 78°53'); in late summer and fall, these fish return along the south shore to Barcelona (Harris and Eschmeyer 1975; Moore 1894; Wolfert and Van Meter 1978). In 1979, ripe and spent adults were caught 3 mi W of Barcelona in April over rocks and gravel in 3-6 ft of water (Griswold and Galati, pers. comm. 1979).

Lake Erie State Park (42°25', 79°26'). The collection of ripe and spent adults in late April suggests that this is a major spawning area. Spawning occurs on a smooth gravel and rock bottom with no vegetation in water approximately 3-6 ft deep (Griswold and Galati, pers. comm. 1979).

Van Buren Point (42°27', 79°25'). This is a spawning area (NYDEC 1977b). In 1976, walleye eggs and prolarvae were collected here in late April (Tex. Instrum. 1977a).

Van Buren Bay (42°27', 79°25'). The presence of ripe adults and the collection of spent adults in late April suggest that this is a major spawning ground. Spawning takes place over gravel and rock in 3-4 ft of water with no vegetation (Griswold and Galati, pers. comm. 1979). Catches of adults increased in the bay in May reflecting the inshore run. Many walleye eggs were found in yellow perch stomachs. A few prolarvae and postlarvae were collected in late May and a few YOY in August (Envirosphere 1977a,b; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1967, gravid, ripe and spent fish were found in the harbor (Tex. Intrum. 1976d, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d). A few adults were impinged at the Dunkirk Steam Station (42°30', 79°21') in March and April. Some adults apparently entered the harbor, although the bottom is silted and unsuitable for spawning (Tex. Instrum. 1977d). Walleye eggs were found throughout the harbor in April (Niagara Mohawk Power 1976, as cited in Tex. Instrum. 1978; Tex. Instrum. 1977d); eggs were entrained at the Dunkirk Steam Station in April and May (Tex. Instrum. 1977e). A few prolarvae were entrained at the station in May; postlarvae were entrained on June 1 (Tex. Instrum. 1977e).

Eagle Bay (42°32', 79°14'). Young-of-the-year are present in the area in July (U.S. Army Eng. Dist., Buffalo, undated a).

Cattaraugus Creek (42°34', 79°08'). Large spawning migrations enter the creek, and the creek mouth is one of the most important spawning areas in New York waters (Buffalo Waterfront Dev. Comm., undated; GLFC 1977).

Evangola State Park (42°37', 79°07'). The entire shoreline from the park to Sturgeon Point (42°41', 79°03') may support spawning (NYDEC 1977b). Catches of ripe and spent adults in April suggest that the park is a major spawning ground. Spawning takes place over rock and gravel in areas with no vegetation in about 3-6 ft of water (Griswold and Galati, pers. comm. 1979).

Eighteenmile Creek (42°43', 78°58'). Anglers report that a spawning run enters the creek (Buffalo Waterfront Dev. Comm., undated). Sunset Bay (42°43', 78°59'), off the mouth of the creek, is one of the best walleye spawning areas in Lake Erie (NYDEC 1977b).

Seneca Shoal (42°47', 78°55'). Gravid fish have been observed here, and spawning occurs. The shoal, composed of sand and rock, is in water approximately 13 ft deep (Griswold and Galati, pers. comm. 1979).

Ontario

OE-1

Comet (42°01', 83°00'). Walleyes spawn about 1 mi offshore (42°00', 83°00') in 23 ft of water (Environ Can. 1977a).

Grecian Shoal (41°58', 82°56'). The rocky shoreline near Colchester (41°59', 82°56') and for several miles west was considered by fishermen to be a spawning ground (Krause 1967).

Canadian reefs (41°48', 82°49'). Egg collecting attempts indicate that the reefs north of the Bass Islands support only limited spawning (Baker 1967b). Only a few eggs were found in the area around East Sister Island (41°48', 82°51'), on Chick Island Shoal (41°46', 82°49'), and on the shoals (41°45', 82°48') south of the Hens and Chickens (Baker 1967b,d; Keller 1964b; Keller and Manz 1963; Manz 1960). Hen Island Shoal (41°49', 82°47') may be a spawning area (Wolfert, pers. comm. 1979).

Pelee Island (41°47', 82°40'). Until recently, large runs of fully ripe adults moved to the shoals around the island; nets set in the area were sometimes covered with spawn (Julien 1967; Krause 1967; Regier et al. 1969; Tiessen 1967). During the 1960s, eggs were collected around the island, mainly off Mill Point (at 41°45', 82°38') (Baker 1964, 1967b; Keller 1964b) and on Chickenolee Reef (41°43', 82°37') (Baker 1964; Keller and Manz 1963); a few were found off Middle Point (41°48', 82°37') (Keller 1964b) and Lighthouse Point (41°50', 82°38') (Keller and Manz 1963). Fry 1.5-2.0 in. long were seined over rocky substrate along the north and east shores of the island (Langlois 1954).

Kingsville (42°02', 82°44'). Ripe walleyes moved onto sand and gravel areas here (Regier et al. 1969); one spawning area was located about 1-3/4 mi offshore (42°00', 82°45') in 28 ft of water (Environ. Can. 1977a). Young-of-the-year were found at Kingsville in September (Selden and Van Meter 1960).

Point Pelee (41°55', 82°30'). The entire shoreline of Point Pelee National Park (41°58', 82°32') is a spawning area (Environ. Can. 1977a). Until recently, large numbers of ripe walleyes moved onto the reefs off the point and onto the gravel and sand areas along the west shore (Julien 1967; Krause 1967; Tiessen 1967); by about 1950, these areas were degraded by domestic and cannery wastes from Leamington (42°01', 82°36') and neighboring towns (Regier et al. 1969). In the spring, adults were first taken by fishermen about 15 mi SE of Point Pelee; the fish then moved towards the shore areas of Pelee Island (41°47', 82°40') and Point Pelee (Krause 1967).

OE-2

Erieau (42°14', 81°55'). Historically, the bays here were spawning grounds (Kerr and Kerr 1860-1898). Walleyes in spawning condition were taken inshore from Wheatley (42°04', 82°26') to Erieau; this area was considered a minor spawning ground (Krause 1967).

OE-3

Big Otter Creek (42°37', 80°48'). A spawning run enters the creek (Environ. Can. 1977a).

OE-4

Inner Bay (42°37', 80°22'). Historically, spawning occurred in lower Big Creek (42°36', 80°27') and at times in the bay off the creek mouth in April or early May. Between 1880 and 1889, it was recognized that the habitat in the creek was being degraded; silt from deforestation and sawdust and bark from sawmills covered the substrate. A dam built in 1889 1 mi upstream from the creek mouth inhibited spawning migrations at least until 1894, and walleyes from the run that spawned in the river were forced to spawn in the bay. In 1930, spawning was further inhibited when a causeway constructed along the west end of Inner Bay cut off the creek from the bay. By 1940, walleyes were almost entirely absent from Inner Bay. Walleyes now rarely spawn in the bay (Kerr and Kerr 1860-1898; Whillans 1977, 1979a,b, pers. comm. 1979).

OE-5

Grand River (42°51', 79°35'). In 1890, a run of walleyes entered the river in the spring (Kerr and Kerr 1860-1898). In 1945, the need for a fish way over the dam near Dunnville was recognized (Ont. Game Fish 1946).

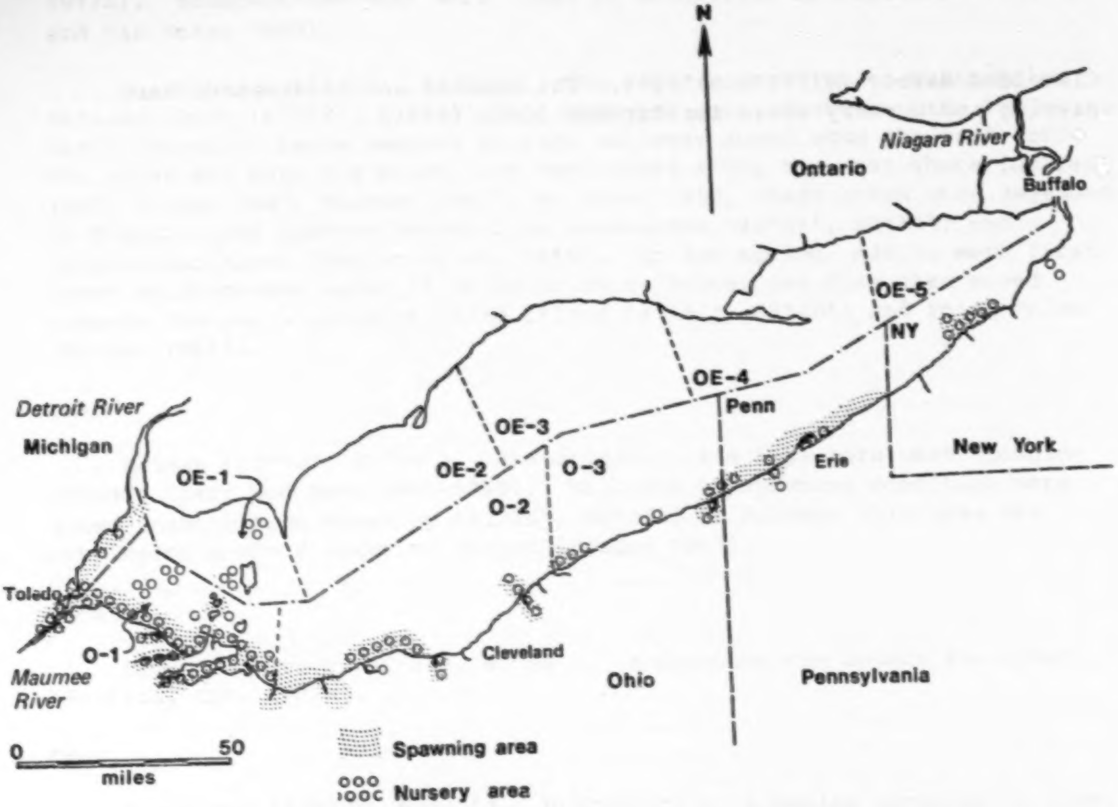
DARTER spp.

Ohio

O-2

Cleveland Harbor (41°31', 81°42'). The beaches and breakwaters here are spawning and nursery areas for darters (Odin 1979).

FRESHWATER DRUM


N
Niagara River
Ontario
Buffalo
OE-5
NY
OE-4
Penn
Detroit River
Michigan
OE-3
OE-1
OE-2
O-3
Erie
New York
O-2
Toledo
O-1
Maumee River
Cleveland
Ohio
Pennsylvania
0
50
miles
Spawning area
Nursery area

In Lake Erie, freshwater drum generally spawn in the spring or early summer at water temperatures of 68-70°F. Movement to spawning areas may begin as early as April at water temperatures of 43°F. Spawning occurs from May through August but mainly in June and July (Bur, pers. comm. 1979; Daiber 1950, 1953; Edsall 1967; Kinney 1954; Scott 1967; Van Oosten 1938; Van Oosten and Hile 1949). Spawning occurs anywhere in bays, on shoals, and in the open lake (FWS 1979d).

The western basin is the major area in Lake Erie used by drum for reproduction; sheltered bays and lower river sections are important spawning and nursery areas (CLEAR 1977; Daiber 1953; Foell 1974; FWS 1979d). The entire south shoreline of the western basin is also a spawning and nursery area (Bur, pers. comm. 1979). Spawning may also occur in the open lake at depths of less than 40 ft (Daiber 1950, 1953). In 1958, spawning occurred from late June to early August (Edsall 1967).

In 1960, the peak hatching period for the western basin was July 1-15 at an average water temperature of 75°F (Comm. Fish. Rev. 1961a). In 1960-76, the highest densities of YOY in U.S. waters usually occurred in the western basin (Anderson 1966; Baker 1966b; Baker and Bower 1965;

Baker and Scholl 1970, 1972; Rudolph and Scholl 1969; Seward 1967; Van Vooren and Davies 1974; Van Vooren et al. 1977). The large adults probably move from the western basin into deeper waters to the east after spawning (Daiber 1950).

In the central basin, drum prefer the slack water of the lower reaches of rivers and harbors (White, pers. comm. 1979). During lakewide surveys conducted during 1958-71, the central basin contained the second highest density of young-of-the-year (YOY) next to the western basin (Anderson 1966; Baker 1966a,b,c, 1969c; Baker and Bower 1965; Baker and Scholl 1970; Rudolph and Scholl 1969; Seward 1967, 1968).

Michigan

In Michigan waters, the freshwater drum usually spawns in early June; larvae are found until mid-July or August (Waybrant and Shauver 1979). Until the 1950s, spawning occurred along the entire shoreline from Stony Point (41°56', 83°16') to the Woodtick Peninsula (at 41°46', 83°26') (Organ et al. 1978).

Pointe Mouillee (42°01, 83°12'). Since the 1950s, spawning has occurred over gravel and mud about 2 mi east of the point, along the western edge of the shipping channel, at 42°03', 83°08'--42°01', 83°09' (Organ et al. 1978).

Pointe Mouillee (42°01', 83°12')--Swan Creek (41°58', 83°15'). In 1935-68, freshwater drum spawned in an area (41°59', 83°12') 2 mi offshore between Pointe Mouillee and Swan Creek at about the 4-6 ft depth contours (Organ et al. 1978).

Fermi Power Plant (41°57', 83°15'). In 1976, prolarvae were collected inshore near the plant intake in early July (Detroit Edison 1978).

Raisin River (41°53', 83°20'). Larvae were very common at the mouth of the river and in nearby lake waters (MacMillan 1976; Nelson 1975); 99% of the freshwater drum larvae taken here were prolarvae, indicating that spawning may have occurred in the immediate area. Larvae were most abundant in the nearshore waters; these either hatched in the area or drifted into the area from Maumee Bay (Cole 1978b; MacMillan 1976). Postlarvae were abundant offshore (Cole 1978a). In 1975-76, many larvae were entrained at the Monroe Power Plant (41°53', 83°21') in June and July (Detroit Edison 1976h).

Woodtick Peninsula (41°44', 83°25'). In 1975-76, very small larvae were most abundant in 6-12 ft of water off the Woodtick Peninsula (at 41°46', 83°25') in mid-July; in 1976, many eggs were collected here and also farther offshore in 12-18 ft of water (at 41°47', 83°23') in early to mid-June (Waybrant and Shauver 1979). In August 1974, YOY were most abundant off the Woodtick Peninsula (MDNR 1970-76). In 1978, larvae were entrained at the Whiting Power Plant (41°47', 83°27'); peak entrainment occurred in June. In 1978, larvae were also collected in the bay off the plant and were most abundant in July (Wapora 1979b).

Ohio

O-1

Maumee Bay (41°43', 83°25') and Maumee River (41°41', 83°28'). Spawning migrations enter the bay and the river in May and June. In 1975, most of the adults collected in the bay in May and June were ripe or gravid (USACE 1976c). Spawning is believed to occur in the bay from approximately June 15 to July 15 at a water temperature of 68°F. Floating eggs were collected in water 5 ft deep (Pinsak and Meyer 1976). Eggs were also collected in the lower Maumee River (CLEAR 1977). Since 1950, freshwater drum have spawned around Turtle Island (41°45', 83°23'), at the mouth of the bay, in 2-10 ft of water (Organ et al. 1978). In the river, young are carried downstream by the current as they absorb their yolk sac. The bay is a nursery area. In the bay, most larvae are found near the bottom (Cole 1978a; Heniken 1977; Snyder 1978). Larvae are found almost exclusively in highly turbid areas; the greatest concentrations in the western basin are found in Maumee Bay and the lower Maumee River, usually in June (Heniken 1977; Herdendorf 1977; Herdendorf and Cooper 1975, 1976; Herdendorf et al. 1976; Patterson 1979a). In 1975, larvae were collected near the mouth of the river and the Bayshore Power Station discharge channel (41°42', 83°26') in July (USACE 1976c). In 1975-77, larvae were abundant throughout the bay in May to July (Herdendorf 1977; Herdendorf and Cooper 1975, 1976). In late June 1975, concentrations of larvae were higher in the inner bay near the mouth of the river and in the lower river than offshore in the bay (Herdendorf et al. 1976).

Locust Point (41°36', 83°05'). Eggs and ripe adults were collected in the Toussaint River (41°35', 83°04') in late May (Rawson, pers. comm. 1979). In 1978, prolarvae were found in moderate densities at the intake of the Davis-Besse Power Station (41°36', 83°04') in late June (Reutter 1979c).

Portage River (41°31', 82°56'). Eggs and ripe adults were collected in the river in late May; YOY were also taken in the river (Daiber 1950, 1952; Rawson, pers. comm. 1979). Drum from the island region enter the river and spawn over clay bottom (Reynolds, pers. comm. 1979).

East Harbor (41°32', 82°47'). In 1969-73, many YOY were collected both inside and outside the harbor; higher concentrations occurred outside the harbor (Ball and Scholl 1973; Gehres and Scholl 1969; Hair and Scholl 1971; Rudolf and Scholl 1969).

Island Region (41°40', 82°45'). In 1953, males with running milt were captured west of Green Island (41°39', 82°52') in late June at a water temperature of 72°F (Kinney 1954). In 1958, eggs were collected in Hatchery Bay (41°39', 82°49') and Squaw Harbor (41°39', 82°49') on South

Bass Island in early July (Davis 1959). Spawning probably also occurs in the open lake, but spawning sites are difficult to identify because the pelagic eggs and larvae are easily transported by currents (Daiber 1950, 1953; Davis 1959). Young-of-the-year were caught in the deep, open lake water around the Lake Erie islands from July to October (Daiber 1950, 1953; Edsall 1967). In 1958, YOY were most abundant among the islands in western Lake Erie and south to the Ohio shore and were relatively scarce off Monroe (at 41°57', 83°12') and the mouth of the Detroit River (at 41°59', 83°05'); they were also moderately abundant north of Huron (at 41°29', 82°33') and at 41°49', 83°00' south of Middle Sister Island (Edsall 1967; pers. comm. 1980).

Sandusky Bay (41°29', 82°46') and Sandusky River (41°27', 82°59'). Large spawning runs enter the bay in late spring and then return to the lake in summer and fall (Bur, pers. comm. 1979; Chapman 1955; Foell 1974). In 1816, large numbers of freshwater drum were observed in the river during the spring (Keeler 1904). Collections of ripe adults and eggs in late May and later collections of YOY indicate that the lower river and the bay are important spawning and nursery grounds (Ball and Scholl 1973; CLEAR 1977; Daiber 1950, 1952, 1953; FWS 1979d; Gehres and Scholl 1969; Hair and Scholl 1971; Hartley 1975; Keller 1964a; Rawson, pers. comm. 1979; Rudolf and Scholl 1969). In the bay, spawning occurs in 6 ft of water over sand or mud bottom (Daiber 1950). Young-of-the-year are collected in May and June (Hartley and Herdendorf 1975). Many YOY were taken in weedy areas at the upper end of the bay from May to October and also around Johnson Island (41°30', 82°44') in lower Sandusky Bay (Ball and Scholl 1973; Daiber 1950; Gehres and Scholl 1969; Hair and Scholl 1971; Keller 1964a; Rudolph and Scholl 1969).

O-2

Huron River (41°24', 82°33'). Heavy spawning runs enter the river in the spring (White, pers. comm. 1979). Eggs and ripe adults have been collected in the river in late May (Rawson, pers. comm. 1979). In 1976, numerous pelagic eggs that were possibly freshwater drum eggs were collected in the lower river during mid-June to late July (Cleveland Environ. Res. Group, undated).

Erie Power Plant site (41°23', 82°30'). In 1974, freshwater drum eggs were abundant in the area. Spawning probably starts in mid-June and continues through August at water temperatures of 62-76°F (Ohio Edison 1977).

Vermilion River (41°26', 82°22'). Historically, large adults were observed in April, along with suckers, on riffles in the river (McCormick 1892). Heavy spawning runs enter the river in the spring (White, pers. comm. 1979).

Beaver Creek (41°26', 82°15'). In 1979, eggs were collected throughout the area off the creek mouth from June 12 to July 5. Prolarvae were found from June 12 to August 22; postlarvae were collected from June 21 to September 4; YOY were found from July 23 to September 4 (Commonw. Assoc. 1979).

Lorain (41°28', 82°11'). In 1892, young (no age given) were common below the dam on the Black River in August and September (McCormick 1892). In 1977, freshwater drum were present onshore during the spawning season, but only a few larvae were collected in the harbor (Geo-Marine 1978).

Avon Lake Power Plant (41°30', 82°03'). In 1975, a few eggs and larvae were collected here in June and July (Aquat. Ecol. Assoc. 1976c).

Rocky River (41°30', 81°50'). Spawning occurs in the river mouth; in 1972-74, YOY were collected in the river (White, pers. comm. 1979; White et al. 1975).

Chagrin River (41°41', 81°26'). A spawning run enters the river; in 1972-74, YOY were collected in the lower river (White et al. 1975). Most larvae were found around the river mouth, but some were collected upstream (Environ. Resour. Assoc. 1978). In 1975, eggs and larvae were collected at the Eastlake Power Plant (41°40', 81°27') near the Chagrin River in June and July; in 1977, they were collected in the same area in late June (Applied Biology 1979b; Aquat. Ecol. Assoc. 1976b). It was assumed that spawning occurred in the immediate vicinity of the power plant (Aquat. Ecol. Assoc. 1976b).

O-3

Perry Power Plant (41°48', 81°09'). In 1972, an inshore run occurred in June; this movement coincided with the spawning season and was probably a spawning migration (NUS 1973). In 1974, freshwater drum eggs were collected at the site from June through August and were most abundant on July 12. Spawning probably occurred from mid-June through August at water temperatures of 59-76°F. Eggs were found almost exclusively in the upper portion of the water column and ~~were most abundant at the middle and~~ offshore stations. Eggs were present as early as June 12, but larvae were not found until July 12. Prolarvae were collected mainly near the bottom. Larvae about 0.2-0.3 in. long were collected at all depths (NUS 1975).

Ashtabula (41°55', 80°47'). In 1977, larvae were collected at the Ashtabula power plants (41°55', 80°46') on June 27 and July 11 (Applied Biology 1979d,e).

Conneaut (41°58', 80°33'). In 1977, eggs were collected in the area extending from Conneaut to Raccoon Creek (41°59', 80°29'), in Conneaut Harbor (41°58', 80°33'), and in the Conneaut River (41°58', 80°33') in June and July at water temperatures of 55-77°F. Larvae were also collected at these locations (Aquat. Ecol. Assoc. 1978c).

Pennsylvania

Freshwater drum spawn anywhere along the Pennsylvania shoreline in water less than 42 ft deep over rock, rubble and clay bottom. Gravid females were collected during spawning season in late June and July along the Pennsylvania shoreline.

Elk Creek (42°01', 80°22'). Ripe adults were present in the creek during May and in the lake during July. Eggs and larvae were collected near the creek (GPU Serv. Corp. 1979).

Presque Isle Bay (42°08', 80°07'). This is a major spawning and nursery area (Kenyon, pers. comm. 1979).

New York

Van Buren Bay (42°27', 79°25'). In waters off Van Buren Bay, freshwater drum eggs were collected in June and July; 95-100% of the eggs collected there were freshwater drum. Prolarvae were collected in mid-June and July, indicating that spawning occurred in late May or early June. Peak abundance of prolarvae occurred in early July. Small numbers of postlarvae were collected in July (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Dunkirk Harbor (42°30', 79°20'). In 1976, prolarvae were entrained on July 6-12 at the Dunkirk Steam Station (42°30', 79°21') (Tex. Instrum. 1977e). Postlarvae were present in Dunkirk Harbor during July (Tex. Instrum. 1977d).

Eagle Bay (42°32', 79°14'). In waters off Eagle Bay, freshwater drum eggs were collected from mid-June to July; 47-99% of the eggs collected there were freshwater drum. Prolarvae were collected in June and July, indicating that spawning occurred in late May or early June; peak abundance of prolarvae occurred in July. Small numbers of postlarvae were collected in July (Envirosphere 1977a,b; Tex. Instrum. 1977a; U.S. Army Eng. Dist., Buffalo, undated a).

Eighteenmile Creek (42°43', 78°58'). Historically, YOY were found in the creek mouth in August (Greeley 1929).

Ontario

OE-1

Pelee Island (41°47', 82°40'). In 1958, YOY were abundant in areas (41°45', 82°45' and 41°50', 82°45') west of the island and in an area (41°56', 82°41') north of the island (Edsall 1967, pers. comm. 1980).

MOTTLED SCULPIN

In the western basin, mottled sculpins spawn over bouldery shoals in late March or April (Langlois 1954). In the central basin, spawning adults and prolarvae were found over a substrate of large rocks including the rock breakwalls of harbors (White, pers. comm. 1979). In 1929, prolarvae and postlarvae were generally found from early June to mid-July, especially along the Canadian shore west of Long Point (Fish 1932).

Ohio

O-1

Portage River (41°31', 82°56'). Historically, a spawning run of mottled sculpins may have entered the Portage River; in 1965 no run occurred (Langlois 1965)

South Bass Island (41°39', 82°50'). Young were abundant around the shores of Buckeye Island (41°40', 82°47') under rocks and among vegetation (Turner 1920a); young were also collected at the end of East Point (41°40', 82°48') under rocks (Langlois 1954).

O-2

Lorain (41°28', 82°11'). A few larvae were collected in Lorain Harbor (41°28', 82°11') (Geo-Marine 1978).

O-3

Ashtabula (41°55', 80°47'). Larvae were collected in the lake from mid-April to late June; 12% of the larvae collected in the spring were mottled sculpin (Applied Biology 1979d,e).

Ontario

OE-4

Long Point Bay (42°40', 80°10'). In 1974, YOY were entrained at the Nanticoke Generating Station (42°48', 80°03') in June and July (Hamley and MacLean 1979; Teleki 1976).

SLIMY SCULPIN

New York

In 1928, larvae were collected in small numbers from the New York-Pennsylvania state line (42°16', 79°46') around to Tecumseh Reef (42°48', 79°44'), Ontario, in 63-76 ft of water in August (Fish 1929, 1932).

Van Buren Point (42°27', 79°25'). In 1975, prolarvae and postlarvae were collected in the lake from early June to July (Tex. Instrum. 1977a).

Eagle Bay (42°32', 79°14'). In 1975, prolarvae and postlarvae were collected in the lake off Eagle Bay from early June to July (Tex. Instrum. 1977a).

Ontario

OE-5

In 1928, larvae were collected in small numbers from Tecumseh Reef (42°48', 79°44') east into New York waters in 63-76 ft of water in August (Fish 1929, 1932).

SCULPIN spp.

Ohio

O-3

Conneaut (41°58', 80°33'). In 1977, sculpin larvae were collected in the Conneaut River (41°58', 80°33'), Conneaut Harbor (41°58', 80°33'), and offshore between Conneaut and Turkey Creek (41°58', 80°33') in June and July; these larvae were believed to have originated from spawning that occurred in nearby tributaries (Aquat. Ecol. Assoc. 1978c).

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This atlas is a compilation of current spawning and nursery information concerning the fishe of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area. The first volume is a summary by geographic area, volumes II through XII contain the specifi areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.

The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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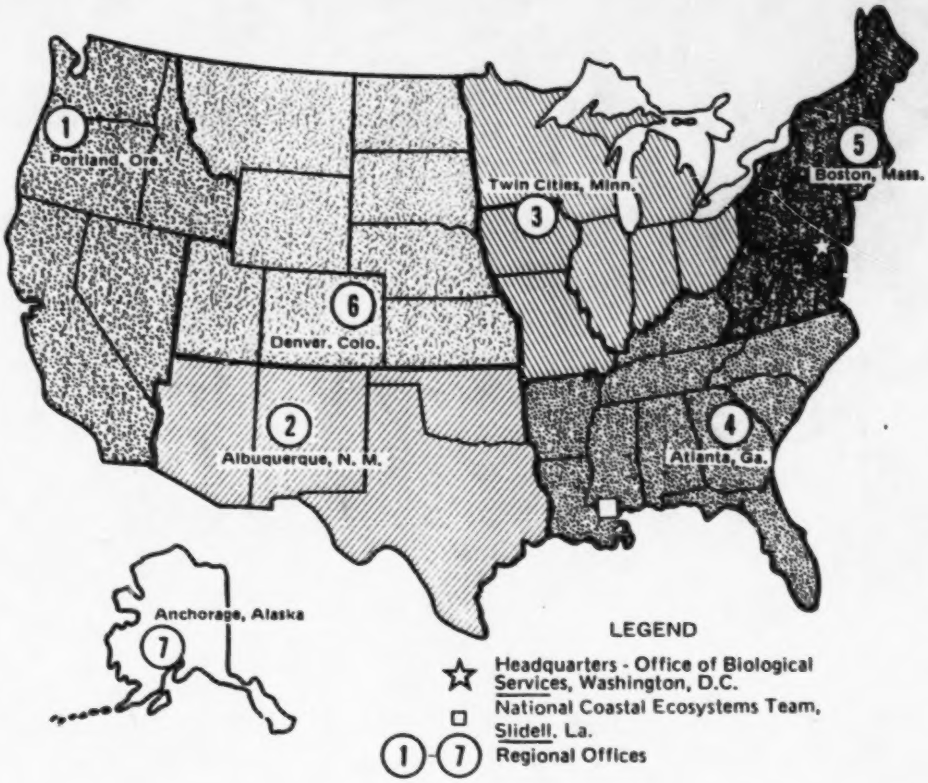

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82/52 v. 10

Biological Services Program

FWS/OBS-82/52
SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume X-Niagara River

Great Lakes-St. Lawrence Seaway Navigation Season Extension Program

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME X
Niaraga River

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area
II. Lake Superior
III. St. Marys River
IV. Lake Michigan
V. Lake Huron
VI. St. Clair River
VII. Lake St. Clair
VIII. Detroit River
IX. Lake Erie
X. Niagara River
XI. Lake Ontario
XII. St. Lawrence River
XIII. Reproductive Characteristics of Great Lakes Fishes
XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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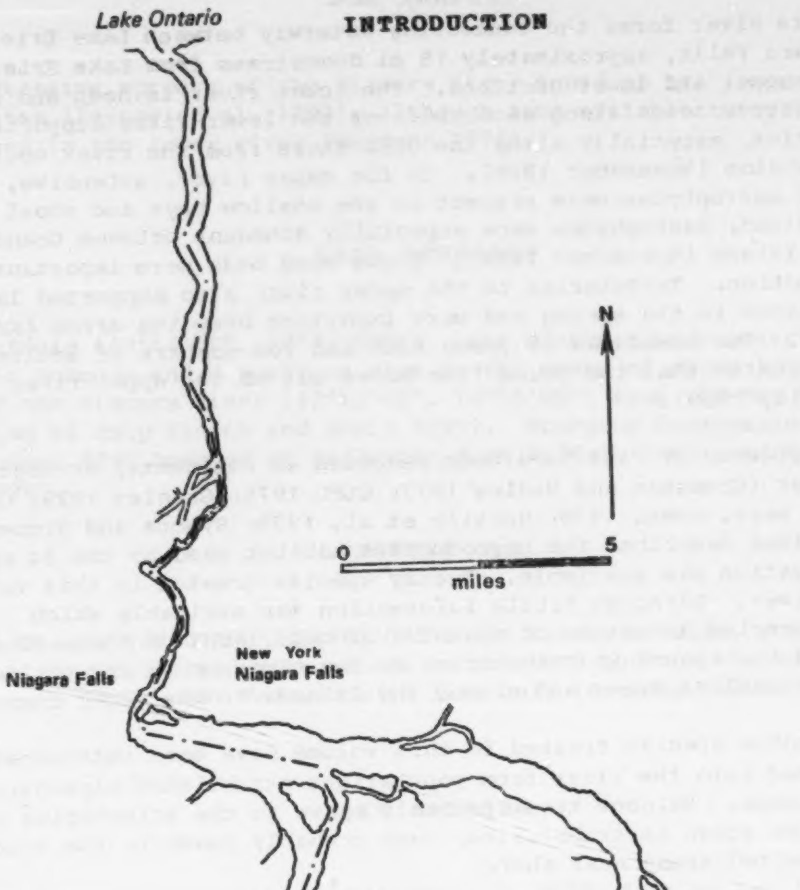
INTRODUCTION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Niagara Falls
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Lake Erie

The Niagara River forms the connecting waterway between Lake Erie and Lake Ontario. Niagara Falls, approximately 15 mi downstream from Lake Erie, divides the river into upper and lower sections. The lower river is deep and swift. Historically, narrow zones along each shore of the lower river supported rooted aquatic vegetation, especially along the U.S. shore from the river mouth upstream to Lewiston (Muenscher 1929). In the upper river, extensive, dense beds of aquatic macrophytes were present in the shallow bays and shoal areas around Grand Island; macrophytes were especially abundant between Grand Island and Strawberry Island (Muenscher 1929). These weed beds were important areas of fish reproduction. Tributaries to the upper river also supported large spawning migrations in the spring and were important breeding areas (Kerr and Kerr 1860-1898). The abundance of young fish and low numbers of adults in the upper river indicated that the young fish moved out of the upper river and into Lake Erie (Greeley 1929).

Almost 80 species of fish have been recorded as residents, or migrants, in the Niagara River (Crossman and Hadley 1977; GLFC 1975; Greeley 1929; OMNR 1973; Shepherd, pers. comm. 1979; Spotila et al. 1979; Symons and Simpson 1939). This volume describes the reproductive habitat used by the 24 species for which information was available. Twenty species treated in this volume are native to the river. Although little information was available which identified the precise locations of spawning grounds, most of these 20 species probably spawned (or spawn) in tributaries to the river or in the shallow embayments and shoreline areas and around the islands in the upper river.

The four exotic species treated in this volume have been introduced by man or have immigrated into the river from populations established elsewhere in the Great Lakes drainage. Rainbow trout probably spawn in the tributaries or along shore. Smelt also spawn in tributaries; carp probably spawn in the tributaries and also in protected areas near shore.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Because the connecting waters have not been assigned to statistical fishing districts (Smith et al. 1971) the species narratives in this volume present the available information by geographic area beginning at the head of the river and continuing downstream to the mouth. For each referenced location within the river the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

For the purposes of this atlas, we define the head of the river as that portion of the river immediately downstream from the line connecting the southern end of the Black Rock Canal (42°53'00", 78°53'30") and Fort Erie (42°53'00", 78°56'00"). The mouth of the Niagara River is that portion of the river immediately upstream from a line connecting Fort Niagara (43°15'40", 79°03'50") and Fort Mississauga (43°15'20", 79°04'40").

SEA LAMPREY

Extensive surveys of the Niagara River found no sea lamprey ammocoetes (Pearce et al. 1980), although some suitable nursery habitat was found in the lower river (Westman 1974).

LAKE STURGEON

Buffalo (42°54'00", 78°53'00"). Lake sturgeon were observed moving about in schools and depositing eggs on the seams of rocky ledges at the head of the Niagara River (42°53'00", 78°55'00") from mid-May to the beginning of July (Smith and Snell 1891). Sturgeon disappeared from the area around 1890 because of pollution from Buffalo (Kerr and Kerr 1860-1898).

LONGNOSE GAR

Tonawanda (43°01'00", 78°53'00"). In the late 1920s, young about 2-3 in. long were collected with seines in the weed beds on the east shore of the Niagara River near Tonawanda in late July (Greeley 1929).

LAKE HERRING

Queenston (43°10'00", 79°03'30"). In 1878, fishing for lake herring was very good near Queenston in late November during spawning runs, which began in late September (Kerr and Kerr 1860-1898).

RAINBOW TROUT

Rainbow trout migrate into the lower Niagara River from Lake Ontario to spawn in the spring (MacCrimmon and Gots 1972; OMNR 1973).

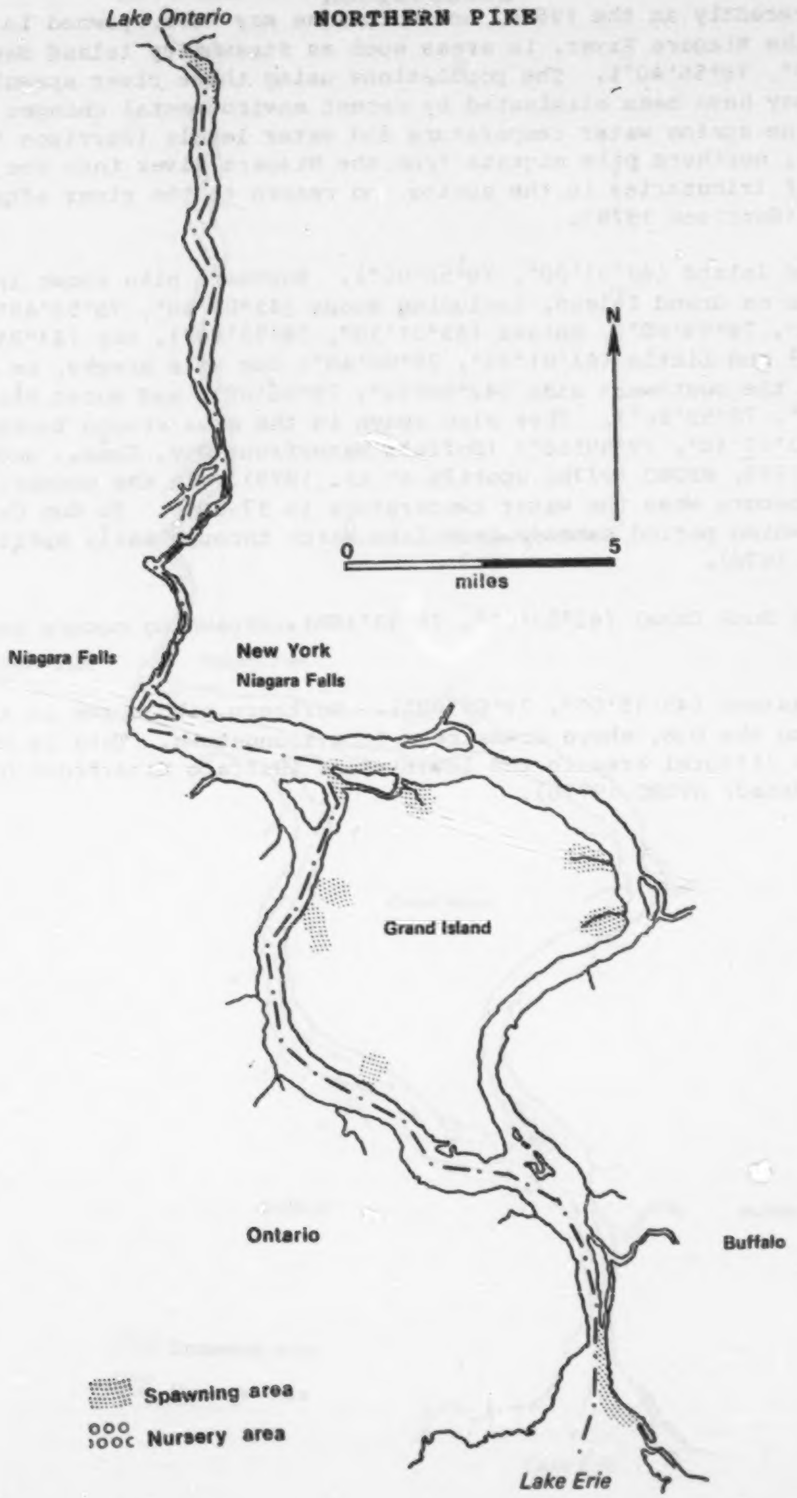
ATLANTIC SALMON

Historically, Atlantic salmon were abundant in the lower Niagara River, upstream to Niagara Falls (43°04'50", 79°04'30") (Parsons 1973). Until the late 1800s, Atlantic salmon migrated into the Niagara River from Lake Ontario to spawn (OMNR 1973).

RAINBOW SMELT

Rainbow smelt were first reported in Lake Ontario in 1929 (Greeley 1929) and in Lake Erie in 1935 (Van Oosten 1937a); there are no early records for this species in the Niagara River. In 1959, a spawning run entered the Niagara River from Lake Erie during late April or May (Roseborough 1962).

NORTHERN PIKE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New York
Niagara Falls
Grand Island
Ontario
Buffalo
Spawning area
Nursery area
Lake Erie

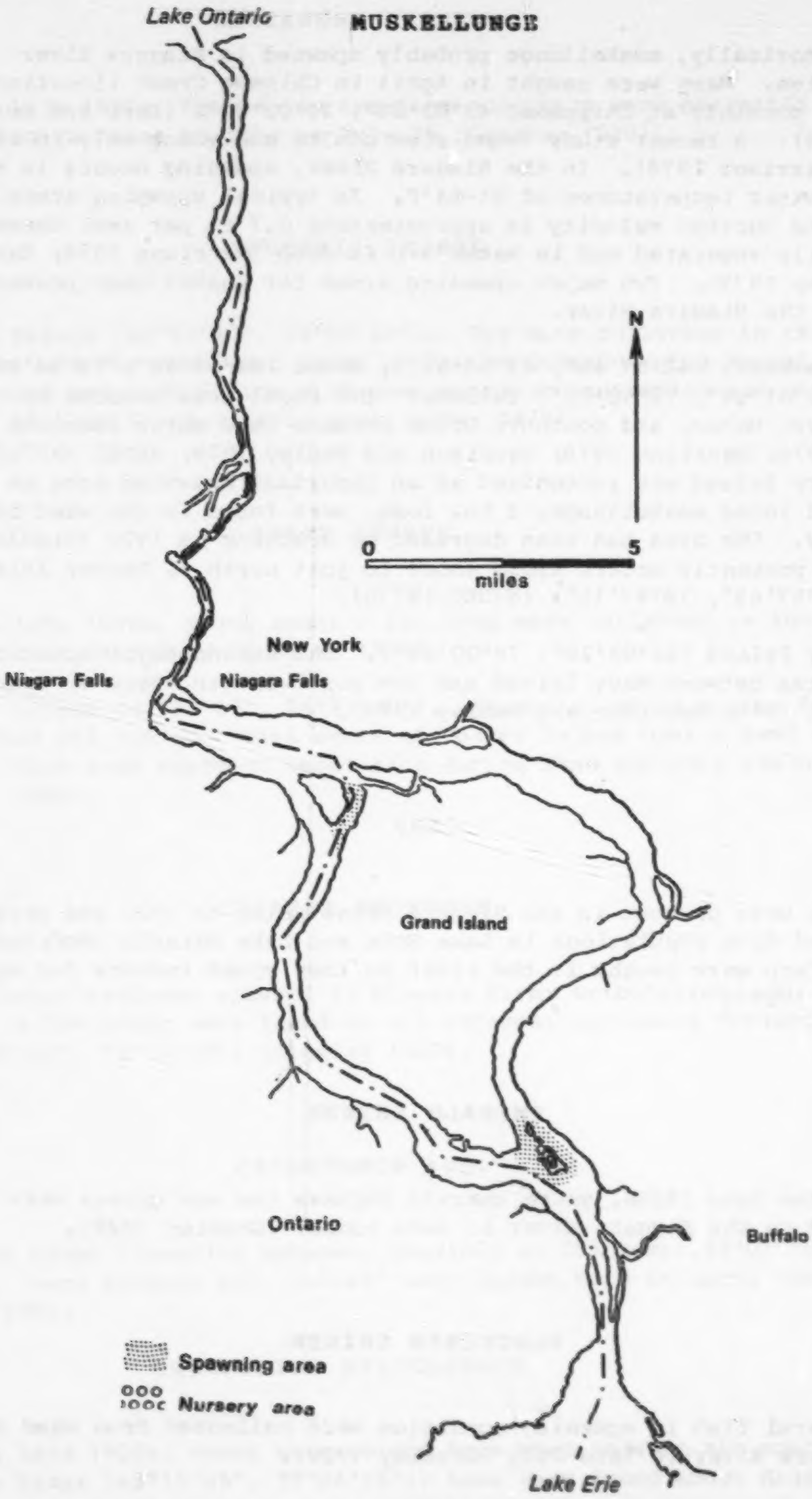
As recently as the 1960s, northern pike may have spawned in the main stem of the Niagara River, in areas such as Strawberry Island Bay (42°57'20", 78°55'40"). The populations using these river spawning grounds may have been eliminated by recent environmental changes that altered the spring water temperature and water levels (Harrison 1978). Presently, northern pike migrate from the Niagara River into the lower reaches of tributaries in the spring and return to the river after spawning (Harrison 1978).

Grand Island (43°01'00", 78°58'00"). Northern pike spawn in most of the creeks on Grand Island, including Woods (43°03'40", 78°58'40"), Gun (43°03'00", 78°55'00"), Spicer (43°01'30", 78°53'40"), Big (43°01'40", 79°00'45") and Little (43°01'45", 79°00'40") Six Mile creeks, an unnamed stream on the southwest side (42°58'50", 79°00'00), and Burnt Ship Creek (43°03'45", 78°59'30"). They also spawn in the area around Buckhorn Island (43°03'40", 79°59'30") (Buffalo Waterfront Dev. Comm., undated; Harrison 1978; NYDEC 1977b; Spotila et al. 1979). In the creeks, most spawning occurs when the water temperature is 37-50°F. In Gun Creek, the major spawning period extends from late March through early April (Harrison 1978).

Black Rock Canal (42°53'00", 78°53'30"). Spawning occurs here (NYDEC 1977b).

Youngstown (43°15'00", 79°03'00"). Northern pike spawn in the lower river along the U.S. shore downstream from Youngstown. This is the only productive littoral area in the lower river (Buffalo Waterfront Dev. Comm., undated; NYDEC 1977b).

MUSKELLUNGE


Lake Ontario
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Niagara Falls
Grand Island
Ontario
Buffalo
Spawning area
Nursery area
Lake Erie

Historically, muskellunge probably spawned in Niagara River tributaries. Many were caught in April in Chipewa Creek (location unknown, possibly at Chippawa, 43°03'30", 79°03'00") (Kerr and Kerr 1860-1898). A recent study found ripe adults and young only in the main river (Harrison 1978). In the Niagara River, spawning occurs in May and June at water temperatures of 61-64°F. In typical spawning areas in the river, the current velocity is approximately 0.7 ft per sec; these areas are heavily vegetated and in water 3-6 ft deep (Harrison 1978; Harrison and Hadley 1979). Two major spawning areas for muskellunge presently exist in the Niagara River.

Strawberry (42°57'45", 78°55'30"), Motor (42°57'30", 78°56'00"), and Grand (43°01'00", 78°58'00") Islands. The shoal area bounded by Strawberry, Motor, and southern Grand islands is a major spawning area (Craig 1976; Harrison 1978; Harrison and Hadley 1978; NYDEC 1977b). Strawberry Island was recognized as an important spawning area as early as 1929, and young muskellunge, 2 in. long, were found in the weed beds in late July. The area had been degraded by dredging in 1927 (Greeley 1929). Spawning presently occurs along shore to just north of Beaver Island State Park (42°57'45", 78°57'15") (NYDEC 1977b).

Navy Island (43°03'20", 79°00'45"). The second major spawning area is the area between Navy Island and the northwestern shore of Grand Island (Harrison 1978; Harrison and Hadley 1978).

CARP

Carp were present in the Niagara River prior to 1900 and presumably originated from populations in Lake Erie and Lake Ontario (McCrimmon 1968). Carp were caught in the river as they moved inshore for spawning (Greeley 1929).

EMERALD SHINER

In the late 1920s, young emerald shiners (no age given) were collected in the Niagara River in late summer (Greeley 1929).

BLACKCHIN SHINER

Several fish in spawning condition were collected from weed beds in the Niagara River in late July (Greeley 1929).

BLACKNOSE SHINER

In the late 1920s, females in spawning condition were collected in the upper Niagara River as late as July 26 (Greeley 1929).

SPOTTAIL SHINER

Beaver Island (42°57'40", 78°57'40"). Fry were collected in the Niagara River off the southwest shore of Beaver Island during August; the area had a sand and rock bottom with some emergent vegetation and little wave action (Griswold and Galati, pers. comm. 1979).

WHITE SUCKER

In the late 1920s, young about 1 in. long were collected in the Niagara River in late July (Greeley 1929).

Beaver Island (42°57'40", 78°57'40"). Recently, white sucker fry were collected off the southwest shore of Beaver Island over a sand and rock bottom with some emergent vegetation during June and July (Galati, pers. comm. 1980).

GREATER REDHORSE

The greater redhorse spawned in Niagara River tributaries. In the late 1920s, a few young were found in all streams, including Tonawanda Creek (43°02'00", 78°53'00") (Greeley 1929).

CATOSTOMID spp.

Chipewa Creek (location unknown, possibly at Chippawa, 43°03'30", 79°03'00"). Many suckers and "mullet" were caught here in April (Kerr and Kerr 1860-1898).

THREESPINE STICKLEBACK

In the late 1920s, young were seined from weed beds at the mouth of the Niagara River (43°15'45", 79°04'15"); none were found above Niagara Falls (43°04'50", 79°04'30") (Greeley 1929).

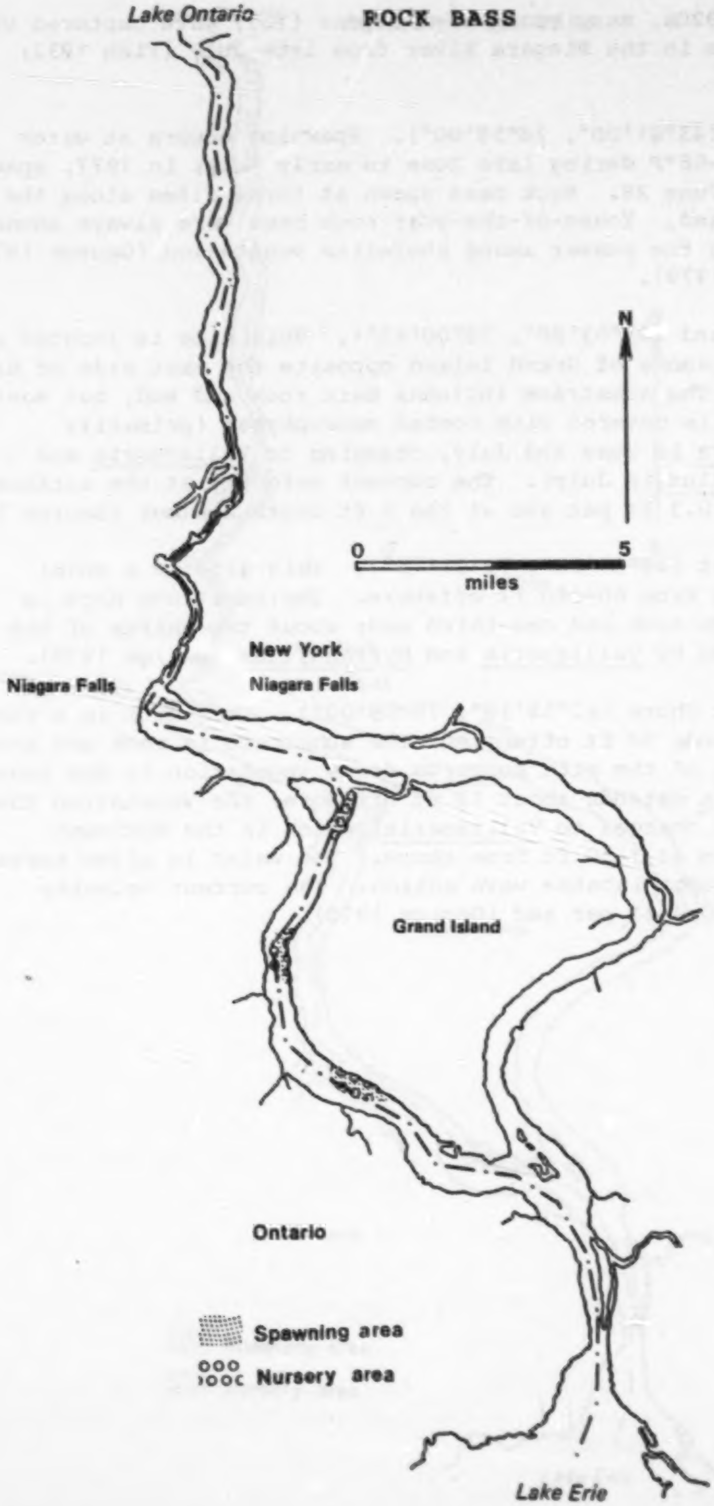
TROUT-PERCH

In the late 1920s, young about 1 in. long were found close inshore in late July (Greeley 1929).

WHITE BASS

In the late 1920s, one young white bass 1 in. long was collected in the Niagara River in late July (Greeley 1929).

ROCK BASS


Lake Ontario
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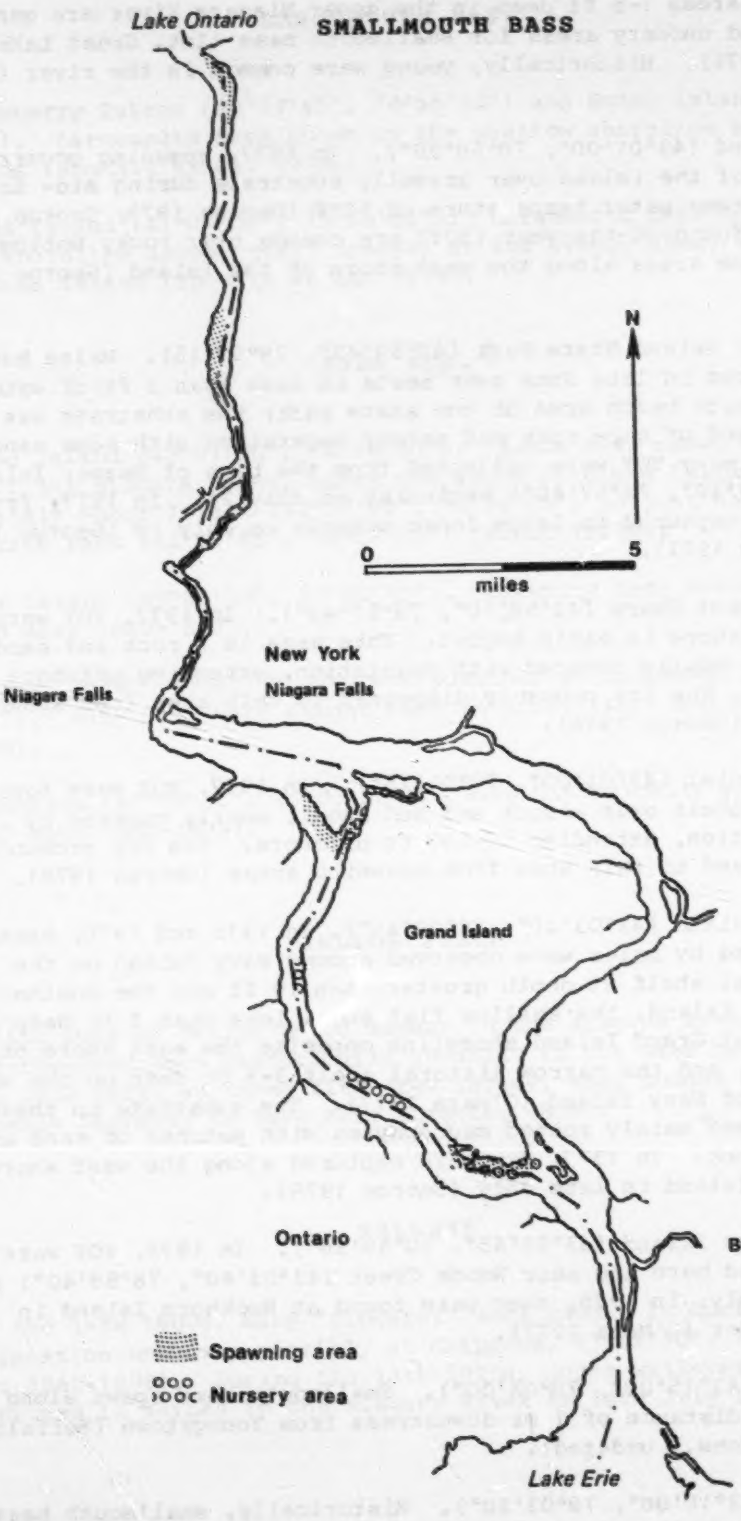
miles
New York
Niagara Falls
Niagara Falls
Grand Island
Ontario
Buffalo
Lake Erie
▨ Spawning area
ooo Nursery area

In the late 1920s, many young-of-the-year (YOY) were captured with seines in weed beds in the Niagara River from late July (Fish 1932; Greeley 1929).

Grand Island (43°01'00", 78°58'00"). Spawning occurs at water temperatures of 63-66°F during late June to early July; in 1977, spawning occurred on about June 28. Rock bass spawn at three sites along the west shore of Grand Island. Young-of-the-year rock bass were always abundant in this area during the summer among shoreline vegetation (George 1978; George and Hadley 1979).

> Navy Island (43°03'20", 79°00'45"). This site is located along the west shore of Grand Island opposite the east side of Navy Island. The substrate includes bare rock and mud, but most of the area is covered with rooted macrophytes (primarily *Cladophora* in June and July, changing to *Vallisneria* and *Myriophyllum* in July). The current velocity at the surface averaged 0.3 ft per sec at the 3 ft depth contour (George 1978).
>
> Cook Point (43°01'00", 79°01'15"). This site is a shoal extending from 60-100 ft offshore. The substrate here is two-thirds rock and one-third mud; about two-thirds of the area is covered by *Vallisneria* and *Myriophyllum* (George 1978).
>
> Southwest Shore (42°58'30", 78°59'00"). This site is a shoal that extends 50 ft offshore. The substrate is rock and sand; about 40% of the site supports dense vegetation in the summer. *Cladophora* extends about 13 ft offshore; the vegetation then gradually changes to *Vallisneria*, which is the dominant vegetation at 3-50 ft from shore. The water is often turbid from frequent intense wave action. The current velocity averages 0.4 ft per sec (George 1978).

SMALLMOUTH BASS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New York
Niagara Falls
Niagara Falls
Grand Island
Ontario
Buffalo
▨ Spawning area
○○○ Nursery area
Lake Erie

The shoal areas 1-5 ft deep in the upper Niagara River are generally the spawning and nursery areas for smallmouth bass (Int. Great Lakes Levels Board 1973). Historically, young were common in the river (Greeley 1929).

Grand Island (43°01'00", 78°58'00"). In 1977, spawning occurred on the west shore of the island over gravelly substrate during mid- to late June, at an average water temperature of 62°F (George 1978; George and Hadley 1979). Young-of-the-year (YOY) are common over rocky bottom in the shallow shoreline areas along the west shore of the island (George and Hadley 1979).

> Beaver Island State Park (42°57'45", 78°57'15). Males have been observed in late June over nests in less than 3 ft of water in the south beach area of the state park; the substrate was composed of bare rock and patchy vegetation with some sand. In 1976, many YOY were collected from the bays of Beaver Island (42°57'40", 78°57'40") beginning on July 24. In 1977, fry were first captured in large loose schools on July 19 (George 1978; O'Mara 1977).
>
> Southwest Shore (42°58'30", 78°57'40"). In 1977, YOY were found along shore in early August. This area is a rock and sand shoal, mostly covered with vegetation, extending offshore about 50 ft. The fry probably dispersed to this area from spawning areas (George 1978).
>
> Cook Point (43°01'00", 79°01'15"). In 1977, YOY were found in late August over a rock and mud shoal, mostly covered by vegetation, extending 60-100 ft offshore. The fry probably dispersed to this area from spawning areas (George 1978).
>
> Navy Island (43°03'20", 79°00'45"). In 1975 and 1976, nests occupied by males were observed around Navy Island on the littoral shelf at depth greater than 10 ft off the southern tip of the island, the shallow flat shoal less than 3 ft deep along the west Grand Island shoreline opposite the east shore of Navy Island, and the narrow littoral shelf 3-5 ft deep on the west shore of Navy Island (O'Mara 1977). The substrate in these areas was mainly rooted macrophytes with patches of sand and bare rock. In 1977, fry were captured along the west shore of Grand Island in late July (George 1978).
>
> Buckhorn Island (43°03'45", 78°59'30"). In 1975, YOY were captured here and near Woods Creek (43°03'40", 78°58'40") in late July; in 1976, they were found at Buckhorn Island in September (O'Mara 1977).

Youngstown (43°15'00", 79°03'00"). Smallmouth bass spawn along the east shore for a distance of 1 mi downstream from Youngstown (Buffalo Waterfront Dev. Comm., undated).

Queenston (43°10'00", 79°03'30"). Historically, smallmouth bass spawned here (Kerr and Kerr 1860-1898).

LARGEMOUTH BASS

Strawberry Island (42°57'45", 78°55'30") and Motor Island (42°57'50", 78°56'00"). Largemouth bass spawn in the shallow shoreline areas around the islands (Spotila et al. 1979).

Grand Island (43°01'00", 78°58'00"). Largemouth bass spawn in shallow, shoreline areas, small creeks, or the swampy areas at the north end of Grand Island (Spotila et al. 1979).

BASS spp.

Grand Island (43°01'00", 78°58'00"). Black bass spawn along the east channel of the Niagara River, along the shore of Grand Island from approximately Motor Island (42°57'50", 78°56'00") to just north of Beaver Island State Park (42°57'45", 78°57'15") (NYDEC 1977b).

Navy Island (43°03'20", 79°00'45"). Spawning beds were observed here (Kerr and Kerr 1860-1898).

Chipewa Creek (location unknown, possibly at Chippawa, 43°03'30", 79°03'00"). Many bass were caught here in April (Kerr and Kerr 1860-1898).

Queenston (43°10'00", 79°03'30"). Bass historically spawned here (Kerr and Kerr 1860-1898).

YELLOW PERCH

Spring runs of yellow perch appear in the Niagara River (USDI 1967). Young-of-the-year were historically abundant in the weed beds of the upper river in late July; as these fish grew larger, they sought deeper water and probably migrated to Lake Erie (Greeley 1929).

WALLEYE

In the late 1800s, many "pickerel" were caught in April in Chipewa Creek (location unknown, possibly at Chippawa, 43°03'30", 79°03'00") (Kerr and Kerr 1860-1898). During the late 1920s, young walleyes 2 in. long were captured in seines in the Niagara River in late July (Greeley 1929).

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This document is one of a set of fourteen volumes.

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This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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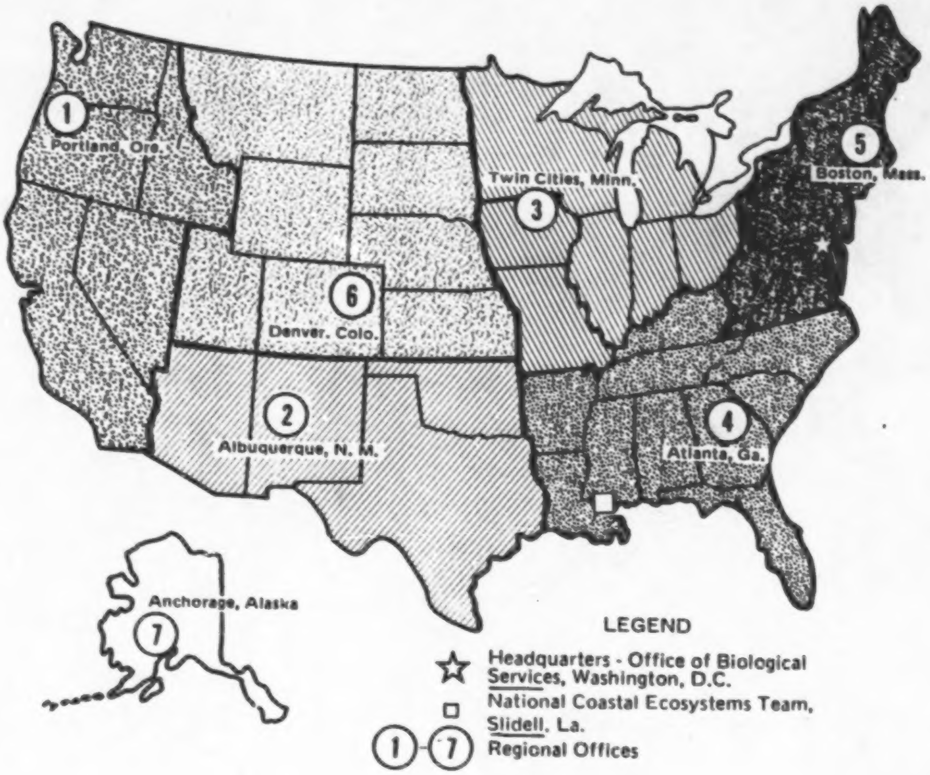
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82/52/v. 11

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SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume XI-Lake Ontario

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME XI
Lake Ontario

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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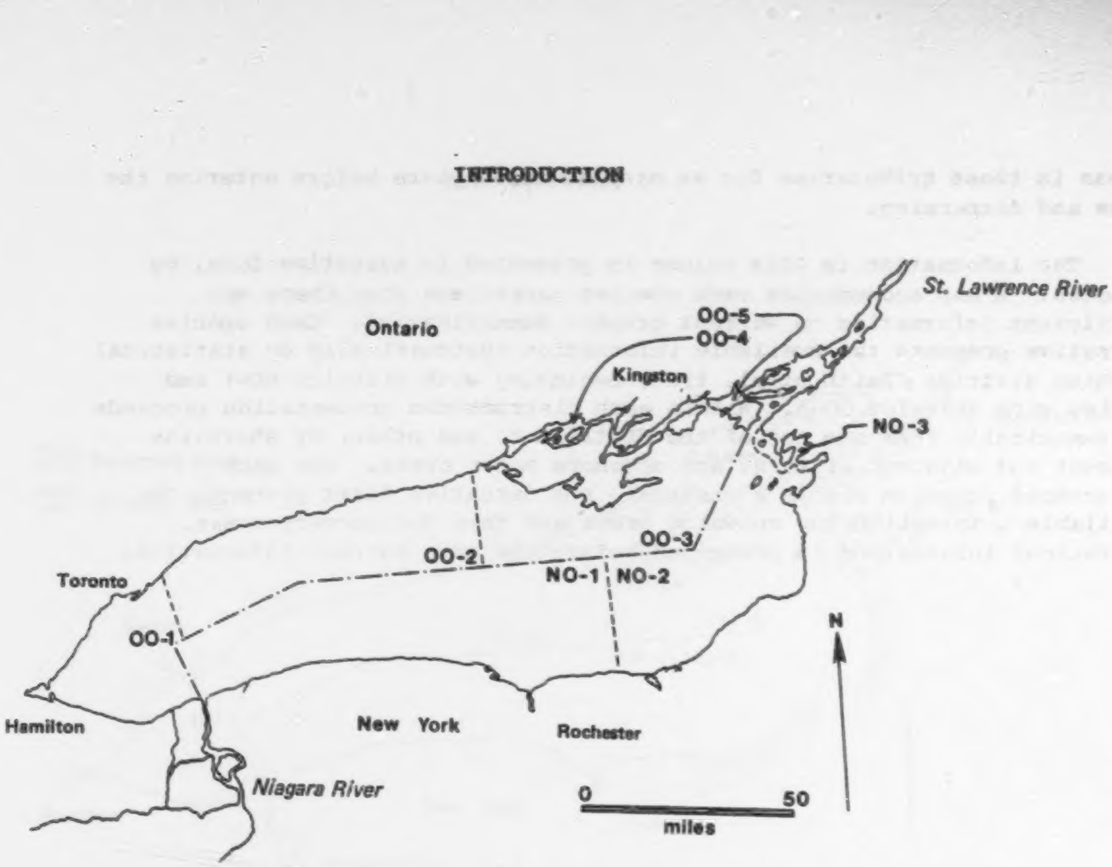
INTRODUCTION



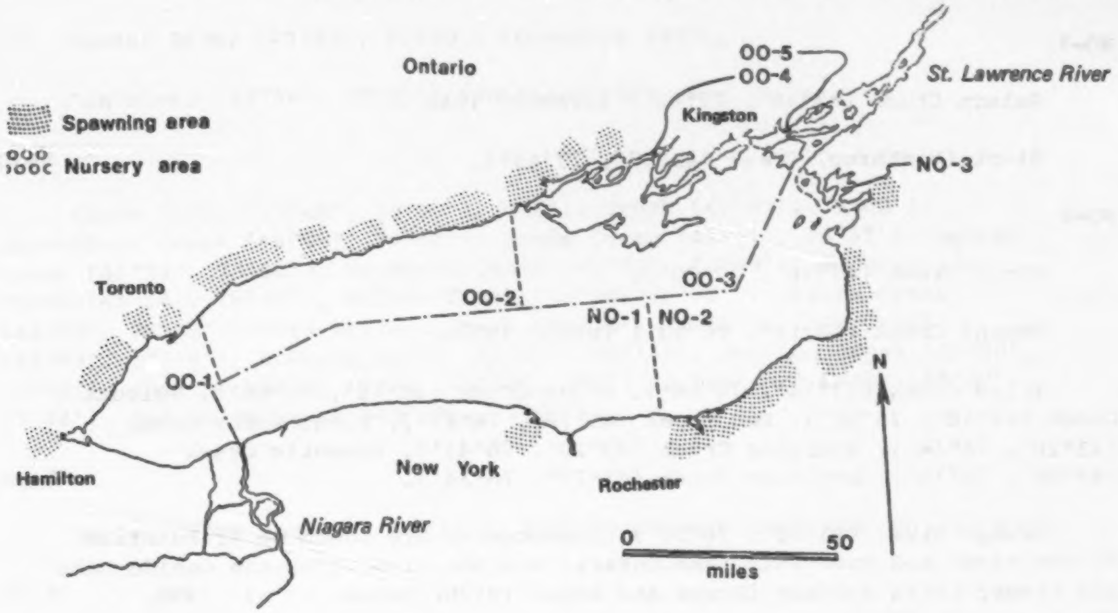
More than 90 species of fish have been recorded as residents in Lake Ontario (Elrod, pers. comm. 1979; Emery 1976; Crossman and Van Meter 1979). This volume describes the reproductive habitat used by the 67 species for which information was available. Fifty-five species treated in this volume were native to the lake. Most of these native species spawned (or spawn) in tributaries or in shallow, protected waters of the lake. Only the lake trout, lake herring, four species of ciscoes, and the slimy sculpin, utilized the deep offshore waters for spawning. Four of these deepwater spawners, the blackfin cisco, shortjaw cisco, deepwater cisco, and kiyi are now believed to be extinct in Lake Ontario. Lake trout and lake herring spawned in the shallow nearshore waters and also the deeper offshore waters.

The 12 exotic species treated in this volume were introduced by man or immigrated to the lake during the period of record, from populations established elsewhere in the Great Lakes drainage. Six of these are salmonids which spawn in tributaries, the other six exotic species spawn in tributaries and also in protected nearshore waters in some areas.

Information on nursery areas used by the 67 species treated in this volume is fragmentary, but as would be expected, it suggests that tributaries and nearshore waters are important as nursery areas, at least for the earliest life stages. Dispersal from spawning areas is rapid for some species which have small, pelagic larvae, whereas the juveniles of some salmonids that spawn in tributaries may remain in or near spawning areas in those tributaries for as many as three years before entering the lake and dispersing.

The information in this volume is presented in narrative form, by species. A map accompanies each species narratiave when there was sufficient information to warrant graphic summarization. Each species narrative presents the available information systematically by statistical fishing district (Smith et al. 1961) beginning with district NO-1 and ending with district OO-5. Within each district the presentation proceeds systematically from one end of the district to the other, by shoreline segment and adjacent littoral and offshore water areas. For each referenced location within a district, the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

SEA LAMPREY



Ontario
Spawning area
Nursery area
OO-5
OO-4
St. Lawrence River
Kingston
NO-3
Toronto
OO-2
OO-3
NO-1
NO-2
OO-1
N
Hamilton
New York
Rochester
Niagara River
0
50
miles

The first reported capture of the sea lamprey in Lake Ontario occurred in 1835 in Duffin Creek (Lark 1973). The sea lamprey may have entered the lake in the early 1820s via the Erie Canal; however, a fish tentatively identified as a sea lamprey was recorded from the lake in about 1817, prior to completion of the Erie Canal, suggesting that the sea lamprey in Lake Ontario may have been a relict species from the Pleistocene Epoch, or that it entered the lake via the St. Lawrence River (Lark 1973; Morman et al. 1980; Pearce et al. 1980).

Ammocoetes have been found in 55 tributaries to the lake (Dees 1980). Spawning occurs most extensively in tributaries along the New York shore from Oswego (43°28', 76°31') to Stony Point (43°50', 76°18') and along the Ontario shore from Toronto (43°38', 79°25') to the Bay of Quinte (44°08', 77°15') (Pearce et al. 1980). Spawning runs are rare or absent along the west half of the southern shore of the lake (Morman et al. 1980). The tributaries listed below are classified as spawning streams based on the presence of ammocoetes, spawning adults, or both.

New York

The following streams have spawning runs (Bails et al. 1971; GLFC 1973b, 1975; NYDEC, unpubl. data; SLCC 1979a; Tibbles 1975; Tibbles et al. 1976a; Torblaa and Westman 1980, unless otherwise noted).

NO-1

Salmon Creek (43°18', 77°45') (Greeley 1940).

Black (Northrup) Creek (43°17', 77°43').

NO-2

First Creek (43°16', 77°00').

Second Creek (43°14', 76°59') (NYDEC 1977b).

Third Creek (43°14', 76°58'), Sodus Creek (43°13', 76°56'), Wolcott Creek (43°16', 76°50'), Red Creek (43°18', 76°47'), Blind Sodus Creek (43°20', 76°44'), Sterling Creek (43°20', 76°41'), Ninemile Creek (43°24', 76°38'), and Rice Creek (43°27', 76°34').

Oswego River (43°28', 76°31'). Ammocoetes are found in tributaries to the river and move into Lake Ontario via the river from the Oneida Lake and Finger Lakes systems (Braem and Rugen 1977b; Morman et al. 1980; Pearce et al. 1980).

Catfish Creek (43°31', 76°19'), Butterfly Creek (43°31', 76°18'), Little Salmon River (43°31', 76°15'), Sage Creek (43°32', 76°14'), Snake Creek (43°32', 76°13'), Grindstone Creek (43°33', 76°13'), Salmon River (43°34', 76°12'), Deer and Little Deer Creeks (43°36', 76°10'), Little Sandy Creek (43°38', 76°10'), Blind Creek (43°39', 76°09'), Lindsey Creek (43°40', 76°10'), Skinner Creek (43°41', 76°10'), South Sandy Creek (43°43', 76°12'), and Stony Creek (43°50', 76°14').

NO-3

Black River (44°00', 76°04').

Ontario

The following streams have spawning runs (GLFC 1973b, 1975; Pearce et al. 1980; SLCC 1979a; Tibbles 1975; Tibbles et al. 1976a,b; Torblaa and Westman 1980; and other references as noted).

OO-1

Ancaster Creek (43°15', 79°56'), Bronte Creek (43°24', 79°43'), and Oakville Creek (43°26', 79°40').

Credit River (43°33', 79°35') (Dymond et al. 1929).

Humber River (43°38', 79°28') (Coventry 1922).

Don River (43°39', 79°21') (Whillans 1977).

OO-2

Rouge River (43°48', 79°07'), Duffin Creek (43°49', 79°02'), Carruthers Creek (43°50', 79°00'), Lynde Creek (43°51', 78°57'), Oshawa Creek (43°52', 78°50'), Farewell Creek (43°52', 78°49'), Bowmanville Creek (43°54', 78°40'), Wilmot Creek (43°54' 78°36'), Graham Creek (43°54', 78°35'), Port Britain Creek (43°56', 78°23'), Gage Creek (43°57', 78°16'), Cobourg Brook (43°57', 78°11'), Grafton Creek (43°58', 78°02'), Shelter Valley Creek (43°58', 78°01'), Lakeport Creek (43°59', 77°54'), and Salem Creek (44°00', 77°50').

OO-3

Butler Creek (44°02', 77°43'), and Smithfield Creek (44°02', 77°40').

OO-4

Trent River (44°06', 77°34'), Moira River (44°09', 77°23'), and Salmon River (44°11', 77°15').

LAKE STURGEON

Historically, lake sturgeon moved into tributaries to spawn during late May to early July (Nash 1913; Rathbun and Wakeham 1897; Smith 1892). This species is no longer considered to be reproducing in the lake proper (Crossman and Van Meter 1979).

New York

NO-1

Youngstown (43°15', 79°03'). Historically, fishermen from Youngstown caught many spawning lake sturgeon during the summer on a bed about 2 mi long and 1/2 mi wide, located in U.S. waters near the Niagara River (Kerr and Kerr 1860-1898); this area may have been Rumsey Shoal (43°17', 79°03').

NO-3

Black River (44°00', 76°04'). Until the 1940s, spawning runs entered the river. Presently there is a dam one mi upstream from the mouth; potential spawning grounds are restricted to the area just below the dam (Eckert, pers. comm. 1979; Jolliff and Eckert, undated).

Ontario

OO-1

Don River (43°39', 79°21'). Until the population declined between 1841 and 1884, lake sturgeon migrated through Toronto Bay (43°38', 79°23') to spawn in the river (Whillans 1977, 1979b).

OO-2

Ganaraska River (43°57', 78°18'). Lake sturgeon supplied early settlers along the river with food (Richardson 1946); this suggests that a spawning run entered the river.

OO-4

Trent River (44°06, 77°34'). Historically, many lake sturgeon attempted to pass over the dam in the lower river (Ont. Game Fish 1916); this suggests that a spawning run entered the river.

Napanee River (44°12', 77°01'). In 1914, large lake sturgeon entered Mohawk Bay (44°11', 77°02') and the river during the summer (Ont. Game Fish 1915); this may have been a spawning run.

LONGNOSE GAR

In Lake Ontario, longnose gars entered the smaller streams, often with the lake sturgeon, to spawn (Goode 1884).

New York

In New York waters, longnose gars are found in embayments along the east shore and are presumed to spawn there (Schneider, pers. comm. 1979).

NO-3

Sherwin Bay Marsh (43°59', 76°10'). In 1975, a few adults entered the marsh in mid-April (Marean 1976).

Point Salubrious (44°02', 76°10'). A spawning ground was located on a beach (precise location unknown) near the point, about one mi from the post office (Goode 1884).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). For many years, a resident population spawned in the bay in the spring (Down, pers. comm. 1979; Moccia, pers. comm. 1979). In the late 1920s, young 5 in. long were found in Burlington Bay (Dymond et al. 1929).

OO-4

Bay of Quinte (44°08', 77°15'). Spawning occurs here in weed beds (Hurley and Christie 1977).

BOWFIN

The bowfin spawns in weedy bays and marshes during May and June (Nash 1913).

New York

Bowfins are found in embayments along the east shore of the lake and are presumed to spawn there (Schneider, pers. comm. 1979).

NO-1

Genesee River (43°15', 77°36'). Bowfins probably entered the lower Genesee River to spawn (Greeley 1927).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Historically, bowfins spawned in the marshes of the bay; they were abundant in the 1890s, declined dramatically in 1961-62, and are now scarce (Whillans 1977).

Toronto Bay (43°38', 79°23'). Bowfins spawned in the bay in 1913 (Whillans 1977).

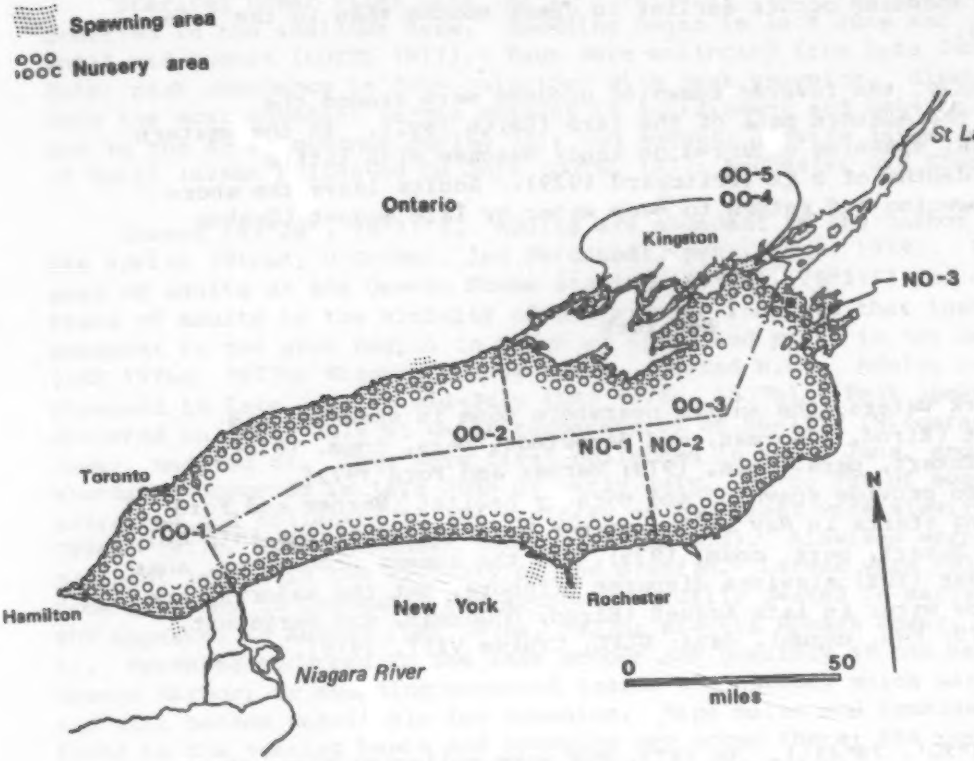
OO-4

Bay of Quinte (44°08', 77°15'). Spawning occurs here in weed beds (Hurley and Christie 1977).

AMERICAN EEL

The spawning grounds of the American eel are in the Atlantic Ocean. Tagging studies have shown that the spawning migration of adults from Lake Ontario down the St. Lawrence River occurs in September and October (Hurley 1972a). Interruption of this migration could be detrimental to the Lake Ontario population (LMS 1977).

ALEWIFE


Spawning area
Nursery area
St Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
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Toronto
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OO-1
Hamilton
New York
Rochester
Niagara River
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miles

Various theories exist regarding the origin of the alewife population in Lake Ontario: the alewife may be native to Lake Ontario (Radforth 1944); may have been accidentally introduced in the 1870s, when American shad were planted in the lake by the U.S. Fish Commission (Bean 1884b); may have entered the lake from New York inland waters; or may have entered the lake via the St. Lawrence River (Smith 1892). Evidence that the alewife is native to Lake Ontario is based only on the fact that the earliest record of occurrence is 1873 (Bean 1884b). A sharp population increase of alewives occurred during the 1870s, and alewives were abundant in the lake by the late 1800s (Miller 1957).

In Lake Ontario, schools of alewives move inshore along the entire shoreline to littoral areas, shallow bays, harbors, and tributary streams where spawning occurs over sand and gravel in late May to early July (Carter et al. 1977; Christie 1973; Elrod, O'Gorman, and Bergstedt, pers. comm. 1979; Pritchard 1929; Rathbun and Wakeham 1897; Schneider and Eckert, pers. comm. 1979; Scott 1967; Smith 1892; Werner and Ford 1972), at water temperatures of 55-60°F (Threinen 1958). The migration begins in early spring (LMS 1979a, as cited in LMS 1980), usually in April (Graham 1956). Spawning peaks between mid-June and mid-July (Graham 1956; LMS 1975c, as cited in LMS 1980). Adults tend to be attracted to the warm water outflow of tributaries during the inshore movement (Bergstedt, pers. comm. 1979). Spawning occurs earlier in creek mouths than in the lake (Greeley 1940).

Historically, the favored spawning grounds were around the shorelines in the eastern part of the lake (Smith 1892). In the western end of the lake, spawning occurred on sandy beaches with little vegetation at depths of 8 ft (Pritchard 1929). Adults leave the shore areas after spawning and return to deep water by late August (Graham 1956).

New York

In New York waters, the entire nearshore zone is spawning and nursery habitat (Elrod, O'Gorman, and Bergstedt, pers. comm. 1979; Schneider and Eckert, pers. comm. 1979; Werner and Ford 1972). Tributaries also provide spawning and nursery habitat (Werner and Ford 1972). Spawning starts in May in the warmer bays and continues into July (Schneider and Eckert, pers. comm. 1979). As the summer progresses, some young-of-the-year (YOY) alewives disperse offshore, but the majority are still in shallow water in late August (Elrod, O'Gorman, and Bergstedt, pers. comm. 1979; FWS, unpubl. data; GLFL, Cruise VIII, 1978).

NO-1

Olcott (43°20', 78°43'). In 1972, YOY were collected along shore (FWS 1978).

Russell Power Station (43°16', 77°38'). In 1977, most of the larvae collected from mid-June to August were alewives; larval abundance peaked in late July (Bio Systems 1978b).

Genesee River (43°15', 77°36'). Historically, large numbers of alewives entered the lower river in the spring to spawn; young were common near the river mouth in early September (Greeley 1927).

Irondequoit Bay (43°14', 77°32'). Spawning occurs in the bay and in the surrounding lake. In 1977, alewives were present in the bay only from mid-May to June. Spent fish were first found in late May (Haines et al. 1977).

Ginna Power Station (43°17', 77°18'). Alewives spawn in the nearshore area in June-August. The area of the discharge plume is a major spawning ground in July. Alewife eggs were the dominant food found in fish in the immediate vicinity (Rochester Gas Elec. 1972). Larvae and YOY dominate collections out to the 36 ft depth contour from late June through August; larval abundance peaks in early August (Bio Systems 1978a).

Little Sodus Bay (43°20', 76°42'). Adults are abundant in the bay in the spring (O'Gorman, pers. comm. 1979); fry and YOY are abundant off Fair Haven from July to October (FWS 1978).

Sterling Power Plant site (43°23', 76°39'). In 1974, spawning occurred in the shallows here. Spawning began in late June and continued until mid-August (LOTEL 1977). Eggs were collected from late June to late July; peak abundance in July coincided with peak spawning. Alewife larvae were the most abundant larvae present in entrainment and lake collections out to the 46 ft contour during July and August; alewife larvae were 95% of total larvae collected in July (LOTEL 1977; Rochester Gas Elec. 1977).

Oswego (43°28', 76°31'). Adults are abundant in the harbor during the spring (Elrod, O'Gorman, and Bergstedt, pers. comm. 1979). Impingement of adults at the Oswego Steam Station (43°28', 76°31') and collections of adults in the vicinity of the station indicate that inshore movement in the area begins in March or April and peaks in May or June (LMS 1976a, 1977b; Niagara Mohawk Power, undated b,c). Adults reach peak ripeness in late June to mid-July (LMS 1976a, 1977b). Peak spawning occurred in early July at water temperatures of 56-72°F (Niagara Mohawk Power, undated b). Eggs were first collected in early June, and peak abundance occurred in late June or early July. Up to 99% of eggs entrained and collected in the vicinity of the plant were alewife (LMS 1976a, 1977b; Niagara Mohawk Power, undated b,c). Alewives were the dominant larvae in the vicinity of the station. Larvae were collected from late May to September and abundance usually peaked in early August; YOY appeared in August (LMS 1976a, 1977b; Niagara Mohawk Power, undated b). Spawning occurred in the lake proper and possibly at the entrance to Oswego Harbor; no spawning occurred inside the harbor, which has a muck and silt bottom unsuitable for spawning. Ripe males and females were found in the turning basin and spawning may occur there; the turning basin is not a nursery area (Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). Spawning occurs in this area; eggs are deposited in Cladophora mats near shore at depths of 3-8 ft (USAEC 1972g; Niagara Mohawk Power 1973). Historically, ripe-running males and females were present in this area in mid-April (Smith 1892). In recent years, most adults were collected during the inshore movement; catches decreased during the summer because of offshore migration (PASNY, undated a). The inshore movement, as reflected by increased impingement of adults at the Fitzpatrick Power Plant (43°31', 76°24') and Nine Mile Point Power Station (43°31', 76°25'), begins in April and peaks in April and May; more than 90% of the total fish impinged at the plant were alewives (LMS 1975a,b, 1976b; PASNY, undated a,b). Spawning begins in late May or early June and peaks during the first half of July at water temperatures of 56-72°F (LMS 1975b; PASNY, undated a). Many eggs were collected in the area and entrained by the plants from June to August; peak abundance usually occurred during the second week of July; up to 97% of the eggs entrained were alewife (LMS 1975b, 1976b; PASNY, undated a,b). Alewife is the dominant species of larvae in the area. Larvae and YOY are collected nearshore and offshore and entrained from June to October (LMS 1975a,b, 1976b; PASNY, undated a,b; QLM 1974).

Montario Beach (location unknown). Historically, large numbers of very young alewives were collected here in mid- and late July (Greeley and Bishop 1932).

Henderson Bay (43°54', 76°10') and Southwick State Park (43°46', 76°13'). In 1972, YOY were collected here from July to October (FWS 1978).

NO-3

Grenadier Island (44°03', 76°21'), Chaumont Bay (44°03', 76°12'), and Black River Bay (43°59', 76°05'). In 1972, YOY were collected here in July to October (FWS 1978).

Wilson Bay (44°05', 76°21'). Young-of-the-year are collected here (Schneider and Eckert, pers comm. 1979).

Ontario

In Ontario waters, large areas along the north shore are probably used for spawning; large numbers of YOY are found in the entire nearshore zone (Balesic 1979c). At most sites between Frenchman Bay (43°49', 79°06') and Wellington (43°57', 77°21'), adults were abundant inshore during the spawning season (Balesic 1979b). Early postlarvae less than 0.3 in. long were found throughout the nearshore surface waters; larvae less than 0.5 in. long were found in surface waters out to about the 10 ft depth contour; larvae larger than 0.5 in. long were found at the surface in offshore waters. The larger larvae appeared to be concentrated in the more protected areas near Brighton (44°02', 77°45') (Dunstall 1979b). Young-of-the-year remain on the spawning grounds until at least the late larvae stage (Graham 1956).

OO-1

Jordan Harbour (43°11', 79°22'). Large runs of adults move into the bay in late spring (Down, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). Since 1930, alewives have spawned in the northwest corner of the bay (Whillans 1977). Large runs enter the bay in about June, when the water temperature rises above 59°F (Down, pers. comm. 1979).

Port Credit (43°33', 79°35'). Inshore migration begins in April and may last until mid-July; most adults move onshore in mid-June, when spawning peaks (Graham 1956). In 1927, spawning did not occur until early July-early August; alewives moved inshore when the water temperature was about 60°F (Pritchard 1929). Adults leave for deeper water immediately after spawning (Graham 1956).

Lakeview Generating Station (43°34' 79°33'). In 1978, alewife eggs were entrained in early August. Early larvae, as small as 0.1 in. long were entrained until the third week in August; larvae as large as 0.7 in. long were entrained until the end of August (Dunstall 1979c).

best copy available

Toronto Islands (43°37', 79°23'). In 1973, large schools of adults in spawning condition were seen here in mid-June (Wainio et al. 1973).

OO-2

Pickering Generating Station (43°48', 79°04'). Alewives concentrate inshore in the spring (Balesic 1979c; Dunford 1976). Larvae are very abundant at temperatures above 60°F; about 98% of the larvae entrained at the station were alewives; 97% and 92% of the larvae taken along the shoreline and further offshore, respectively, from June to August were alewives (Balesic 1979c; Dunford 1977; Dunstall 1978b). Most eggs entrained from June to August were probably alewife eggs (Dunstall 1978b). In 1976, cold upwellings delayed spawning until early August. Spawning may have occurred at the intake groin, over Cladophora-covered stone; a concentration of larvae was found over sand near this site (Dunford 1977).

Darlington Generating Station site (43°52', 78°43'). Extensive spawning in this area was indicated by the abundance of early larvae there (Dunford 1979; Dunstall 1979b). Trap net catches indicated that adults migrate through the area in early summer (Dunford 1976c).

Wesleyville Generating Station site (43°55', 78°25'). Spawning occurs here (Dunford 1979). In 1978, YOY dominated trawl collections in early fall (Balesic 1979b).

Grafton Creek (43°58', 78°02'). In 1975, spawning alewives were found in the creek mouth in late May (Tibbles 1975).

OO-3

Brighton (44°02', 77°45'). Larger larvae appear to be concentrated in the protected areas here (Dunstall 1979b).

OO-4

Bay of Quinte (44°08', 77°15'). Alewives move into shallow areas and spawn over sand or mud, when the surface water temperature reaches about 60°F (Pritchard 1929). Inshore migration begins in April and may last until late July; most adults arrive onshore in late June, and spawning peaks in late June or early July. There is a gradual movement of adults to deeper water after spawning (Graham 1956). Spawning occurs in Hay Bay (44°07', 77°01') (Christie 1973) and also in the discharge canal of the Lennox Generating Station (44°09', 76°51'), where concentrations of adults, eggs, larvae and YOY were found in June-August (Balesic 1978; Dunford 1978a). Spawning near the Lennox station begins slightly earlier than at other locations on the north shore (Dunford 1979). Eggs were often found adhering to weeds near shore in the Bay of Quinte (Lam 1977). Alewife larvae were present throughout the bay during the entire summer (Hurley and Christie 1977; Lam 1977; Payne 1964); their presence until late August reflected the extended spawning season of the alewife (Noakes, pers. comm. 1979). In 1974, the greatest concentrations of larvae occurred in Hay Bay and the upper Bay of Quinte (Lam 1977). In 1975, major concentrations of newly-hatched larvae were also found at Indian Point (44°07', 76°51') and Pig Point (44°08', 76°49'), suggesting that these were important spawning sites (Griffiths 1976b).

GIZZARD SHAD

The gizzard shad apparently entered Lake Ontario from Lake Erie. The first record of gizzard shad in the lake is in 1913, although a fish that probably was gizzard shad was reported about 1837 (Miller 1957).

New York

NO-2

Oswego (43°28', 76°31'). In 1975-76, spawning occurred in the harbor. Eggs were collected from early June to early July in the harbor turning basin; larvae were also collected (Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). A spring inshore movement is indicated by the impingement of many adults at the Nine Mile Point Power Station (43°31', 76°25') during April (QLM 1974). Eggs were found in the lake and entrained at the station from mid-June to mid-July (LMS 1975b, 1976b; PASNY, undated a,b); larvae were also entrained (LMS 1976b).

Ontario

OO-1

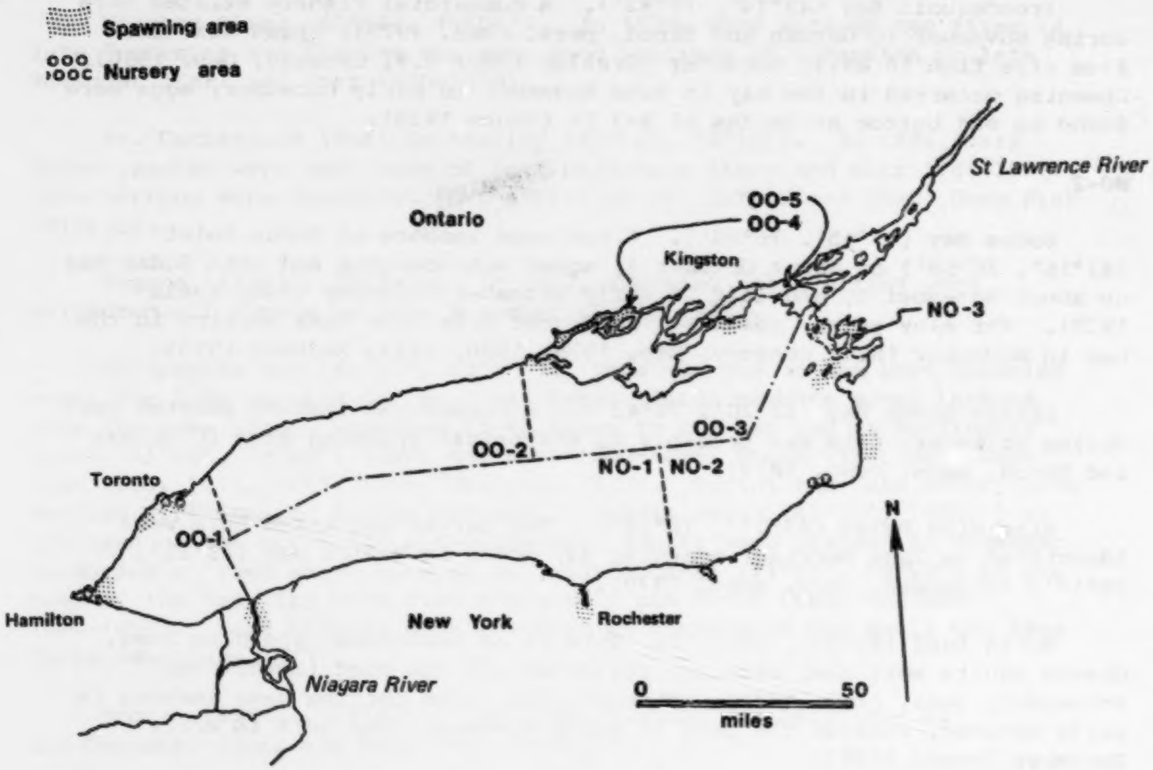
Jordan Harbour (43°11', 79°22'). Large numbers of gizzard shad enter the bay in late spring (Down, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). Large numbers of gizzard shad enter the harbor area in late spring, when the water temperature rises above 59°F (Down, pers. comm. 1979). Gizzard shad spawn in the northwest corner of the bay (Whillans 1977). Many are caught off Hamilton Beach (43°17', 79°47'); they also enter Spencer Creek (43°15', 79°57') and Grindstone Creek (43°17', 79°53') at the head of the bay (Moccia, pers. comm. 1979).

OO-4

Bay of Quinte (44°08', 77°15'). Gizzard shad spawn in the bay. In 1974, eggs were observed attached to Myriophyllum. The adults probably migrated into the warmer shallow water of the upper bay to spawn. Larvae were present throughout the bay during June to September, but were concentrated in enclosed embayments in the upper bay and in upper Hay Bay (44°10', 76°56') (Lam 1977).

LAKE HERRING


Spawning area
Nursery area
St Lawrence River
Ontario
OO-5
OO-4
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
OO-1
N
Hamilton
New York
Rochester
Niagara River
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50
miles

Historically, the lake herring migrated to inshore areas of Lake Ontario in large numbers to spawn over sand or "finger rock" in mid- to late November; adults returned to deeper water in early December soon after spawning (Koelz 1926, 1929; Nash 1913; Rathbun and Wakeham 1897; Smith 1892). Two forms of lake herring were present. A "shallow-water" or "greenback" herring, spawned on shoals and in bays at depths as shallow as 10 ft. A "deepwater" or "blueback" herring, was found primarily at the western end and spawned on the bottom at depths of 90-180 ft (Greeley 1940; Koelz 1929). Presently, lake herring are found throughout Lake Ontario in low numbers (Eckert and Schneider, pers. comm. 1979).

New York

In New York waters, most lake herring were taken during the spawning season along the shoreline from Sodus Bay (43°15', 76°58') east to the St. Lawrence River (Koelz 1926). Spawning has occurred in the following areas:

NO-1

Wilson (43°19', 78°50'). Until 1900, lake herring were common here at depths of 90-120 ft in October and November (Koelz 1929).

Irondequoit Bay (43°14', 77°32'). A commercial fishery existed here during November (O'Gorman and Elrod, pers. comm. 1979); spawn was taken from ripe fish in early December (Greeley 1940; N.Y. Conserv. Dep. 1930). Spawning occurred in the bay in late November to early December; eggs were found on mud bottom at depths of 4-7 ft (Stone 1938).

NO-2

Sodus Bay (43°15', 76°58'). A run came inshore at Sodus Point (43°16', 76°59') on about October 1, moved onto beaches and into Sodus Bay on about November 1, and left in early December (Greeley 1940; Koelz 1929). For many years, spawn was collected from ripe lake herring in the bay in November (N.Y. Conserv. Dep. 1929, 1930, 1931; Redband 1915).

Little Sodus Bay (43°20', 76°42'). A commercial fishery existed here during November; this was probably an historical spawning area (O'Gorman and Elrod, pers. comm. 1979).

Nine Mile Point (43°31', 76°22'). Two larvae collected here were identified as lake herring; spawning may occur in Mexico Bay (43°33', 76°17') (O'Gorman, pers. comm. 1979).

North Pond (43°39', 76°11'). This is an historical spawning area. Gravid adults were also recently collected off the pond (Eckert and Schneider, pers. comm. 1979). Historically, lake herring came inshore in early October, entered the pond in early November, and left in early December (Koelz 1929).

Stony Island (43°54', 76°20'). Spawning occurred here (Rathbun and Wakeham 1897).

NO-3

Point Peninsula (44°00', 76°15'). Spawning occurred on the south side of the point (Rathbun and Wakeham 1897).

Grenadier Island (44°03', 76°21') (Rathbun and Wakeham 1897).

Chaumont Bay (44°03', 76°12'). Lake herring came inshore to spawn in Chaumont Bay and Three Mile Bay (44<04', 76°13') during mid- to late November (Eckert and Schneider, pers. comm. 1979; Koelz 1929; Rathbun and Wakeham 1897).

Ontario

Historically, the western end of the lake was the major spawning area in the lake (Pritchard 1931b; Rathbun and Wakeham 1897). The deepwater herring were found in the western end (Koelz 1929); very large numbers came inshore and then moved about 2 mi offshore some weeks later to spawn (Kerr and Kerr 1860-1898). Spawning occurs in November (Pritchard 1928).

OO-1

Niagara River (43°16', 79°04'). In 1878, runs entered the river in late September and fishing was very good upstream at Queenston in late November (Kerr and Kerr 1860-1898).

St. Catharines (Port Dalhousie) (43°12', 79°16'). In 1891, very large catches were made west of Port Dalhousie (Kerr and Kerr 1860-1898). Lake herring were plentiful in the fall at St. Catharines (Ont. Game Fish 1913a,b).

Winona (43°13', 79°39'). In 1917, spawning lake herring were collected off Winona in late November (Koelz 1929).

Burlington Bay (43°17', 79°50'). This was one of the best spawning areas for lake herring in the Great Lakes; large numbers moved inshore from the lake around November 15 to spawn in the bay and at Burlington Beach (43°18', 79°48') (Kerr and Kerr 1860-1898; Koelz 1929; Ont. Game Fish 1906, 1911, 1915, 1916; Whillans 1977). During the late 1800s, lake herring were speared in the bay and in Dundas Marsh (43°16', 76°57') at the head of the bay until mid-December. Adults were present in November in Mordon's Creek which entered Desjardins Canal (43°15', 79°57') at the head of the bay; fry were also present in the creek (Kerr and Kerr 1860-1898). Lake herring were abundant in Burlington Bay until the late 1920s (Whillans 1977).

Bronte (43°24', 79°43'). In 1886, fishing was very good in mid-December (Kerr and Kerr 1860-1898).

Port Credit (43°33', 79°35'). In 1926, ripe and spent lake herring were taken here in late October (Pritchard 1928).

Toronto (43°38', 79°25'). Historically, runs of gravid lake herring moved to the shore of Toronto Island (43°37', 79°24') and into Toronto Bay (43°38', 79°23'). During 1880-1893, the runs were heavily fished; these runs ceased in about 1900 (Whillans 1979b, pers. comm. 1979). In 1877, many lake herring fry were caught under the ice in February for use as bait (Kerr and Kerr 1860-1898).

OO-3

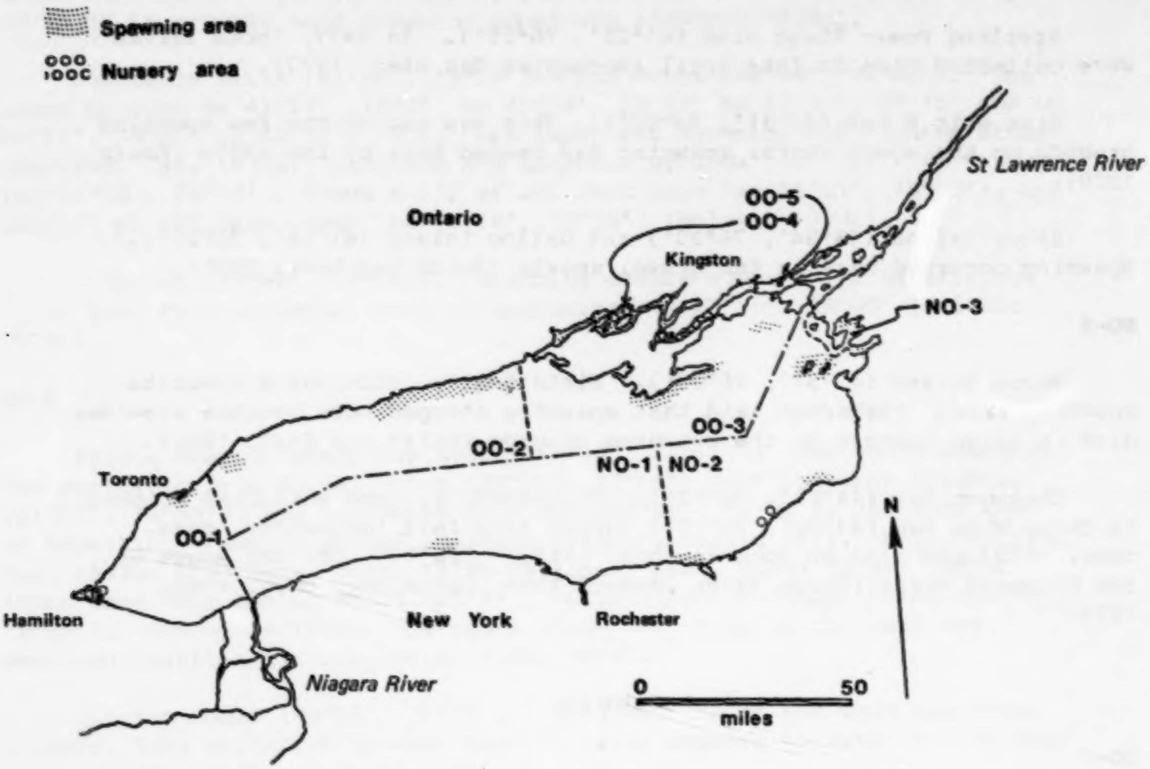
Brighton (44°02', 77°45'). Historically, lake herring moved onto shoals in the area on about October 1; by about November 1 they had moved into Wellers Bay (44°00', 77°35') and Presqu'ile Bay (44°01', 77°42') (Koelz 1929). The east side of Bald Head Beach (44°00', 77°36') in Wellers Bay is a spawning area (Environ. Can. 1977a). Spawning also occurred just outside Wellers Bay (Whillans, pers. comm. 1979).

Amherst Island (44°09', 76°43'). Adults were collected off the southwest end of the island in late November; of these, 22% were spent, 21% were partly spent, and 32% were ripe (Fry 1937).

OO-4

Bay of Quinte (44°08', 77°15'). Large runs entered the bay; spawning occurred on gravel shoals in 10 ft of water in November at water temperatures of approximately 37-43°F (Dymond et al. 1929; Hurley and Christie 1977; Pritchard 1928, 1931a, 1931b; Rathbun and Wakeham 1897). Until 1928, a profitable fishery existed as far up the bay as Trenton (44°06', 77°34') (Dymond et al. 1929; Ont. Game Fish 1915). During the 1940s, spawn was still collected in the bay (Ont. Game Fish 1940, 1943, 1944, 1945). Spawning occurred at Big Island (44°05', 77°15') and at Hogs Back Reef (900 ft north of Big Island), where eggs were found in crevices between stones at depths of 8-10 ft. Spawning also occurred at Cedar Island (44°09', 77°20'), and near Belleville (44°09', 77°23') (Pritchard 1931a, 1931b). Eggs remained on the bottom and hatched in April or May (Pritchard 1931a), 3-4 weeks later than the Lake Whitefish (Hart 1930). In the late 1920s, young herring were found at the head of Prinyer Cove (44°05', 76°53') in protected water among reeds (Pritchard 1929, 1931a).

LAKE WHITEFISH


Spawning area
Nursery area
Ontario
St Lawrence River
OO-5
OO-4
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
OO-1
N
Hamilton
New York
Rochester
Niagara River
0
50
miles

In Lake Ontario, lake whitefish spawn on gravel, rock, or honeycombed rock reefs at depths of 6-60 ft during November and early December. Declining water temperatures initiate the inshore migration to spawning grounds in about mid-October, and spawning occurs at about 40°F (Elliot 1942; Geare 1884; Kerr 1874; Koelz 1929; MacKay 1969; Milner 1874b; Nash 1913; Rathbun and Wakeham 1897; Smith 1892). Spawning grounds are concentrated in the eastern end of the lake and along the north shore, mainly in Canadian waters east of Brighton (44°02', 77°45'); these are generally the same areas that were used by lake trout (Koelz 1926, 1929; Rathbun and Wakeham 1897; Rodd 1919; Smith 1892; USBCF 1969a; USDI 1969b).

New York

NO-1

Oak Orchard (43°22', 78°12'). This was one of the few spawning grounds on the south shore; spawning had ceased here by the 1920s (Koelz 1929).

NO-2

Sodus Point (43°16', 76°59'). Historically, a large run occurred here (Smith 1892).

Sterling Power Plant site (43°23', 76°39'). In 1977, three larvae were collected here in late April (Rochester Gas Elec. 1977).

Nine Mile Point (43°31', 76°22'). This was one of the few spawning grounds on the south shore; spawning had ceased here by the 1920s (Koelz 1929).

Stony Island (43°54', 76°20') and Galloo Island (43°54', 76°25'). Spawning occurred here on the gravel shoals (Smith and Snell 1891).

NO-3

Horse Island (43°57', 76°09'). Historically, this was a favorite spawning site. Fishermen said that spawning stopped here because alewives died in large numbers on the spawning grounds (Smith and Snell 1891).

Chaumont Bay (44°03', 76°12'). Historically, lake whitefish spawned in Three Mile Bay (44°04', 76°13') during late fall (Schneider, pers. comm. 1979) and also on Johnson Shoal (44°03', 76°10') off the mouth of the Chaumont River (Green 1908; Ravenel 1898; Schneider, pers. comm. 1979).

Ontario

OO-1

Grimsby (43°12', 79°34')--Winona (43°13', 79°39'). Historically, many lake whitefish were caught in the fall in this area (Kerr and Kerr 1860-1898). Lake whitefish fry were planted on the "whitefish bar," 1 mi offshore from Winona (Ont. Game Fish 1915); this may have been an historical spawning ground.

Burlington Bay (43°17', 79°50'). Until the early 1930s, a large spawning run entered the bay in November (Whillans 1977). In the late 1800s, a school of fry was observed at Willow Point (Kerr and Kerr 1860-1898). Spawning "beds" were observed in the Hamilton area (Ont. Game Fish 1912) and 3/4 mi offshore from Burlington Beach (43°18', 79°48') (Ont. Game Fish 1908).

Toronto Island (43°37', 79°24'). Until the early 1880s, runs of ripe fish were recorded along Toronto Island and adjacent shores (Whillans 1977, pers. comm. 1979).

OO-2

Port Union (43°47', 79°08'). In 1865, spawning occurred here (Kerr and Kerr 1860-1898).

Darlington Park (43°52', 78°48'). In 1975 and 1977, a few adults in spawning condition were found here (Dunford 1976c, 1978c).

Raby Head (43°52', 78°43'). A few adults in spawning condition were found in shallow water in November; patches of gravel and rubble at depths of 10-40 ft provide good spawning substrate (Dunford 1978c).

Bouchette Point (43°54', 78°29')--Chub Point (48°58', 78°00'). The areas bounded by 43°54', 78°28' to 43°56', 78°12' to 43°57', 78°15' and by 43°51', 78°00' to 43°55', 78°30' are important spawning and fishing areas (Environ. Can. 1977a); included are spawning grounds just off Port Granby (at 43°54', 78°28'), about 4-1/2 mi off Port Hope (at 43°53', 78°18'), and about 1 mi off Gage Creek (at 43°56', 78°16') (Balesic 1979c).

Colborne (43°59', 77°54'). Spawning occurs about 4-1/2 mi offshore in an area from Colborne, west to approximately 43°55', 78°00' (Balesic 1979c).

OO-3

Prince Edward County Peninsula (44°00', 77°15'). The south shore of the peninsula from Wicked Point (43°51', 77°14') east to Point Traverse (43°57', 76°52'), and including Gull Bar (43°56', 76°50'), has long been an important spawning ground (Balesic 1979c; Christie 1972, 1973; Environ. Can. 1977a; Sly, pers. comm. 1979; Whillans, pers. comm. 1979). Major areas used were Poplar Point (43°55', 76°55') and Ostrander Point (43°54', 76°59'). Since the 1940s, the catch along the shore in the fall has declined drastically (Sly, pers. comm. 1979).

Charity Shoal (44°03', 76°29'). This was one of the most important grounds; lake whitefish spawned here in large numbers in water 5-7 ft deep (Smith 1892; Smith and Snell 1891).

OO-4

Bay of Quinte (44°08', 77°15'). Large numbers of lake whitefish migrated to spawning grounds very close to shore between Glenora (44°02', 77°04') and Picton (44°01', 77°08') each fall (Lapworth 1956). The bay was a favorite spawning ground and was the site of one of the most important whitefish fisheries and spawn collecting operations in the lake in October and November; profitable fisheries were operated during the spawning runs as far up the bay as Massasauga Point (44°09', 77°19') and Belleville (44°09', 77°23') (Dymond et al. 1929; Koelz 1929; Ont. Game Fish 1910, 1911, 1913a, 1915, 1916, 1940; Ravenel 1898; Rodd 1914, 1917, 1918; Smith 1892). Spawning occurred on gravel shoals and beaches in the same areas used by lake herring (Hart 1930; Hurley and Christie 1977; Pritchard 1931). Historically, the most extensive spawning grounds were near Trenton (44°06', 77°34') at the head of the bay; these were probably degraded by sawdust and other mill wastes entering the bay (Rathbun and Wakeham 1897). Lake whitefish eggs were found at Hogs Back (Hogsback Shoal), 900 ft north of Big Island (44°05', 77°15'), in crevices between rocks and under stones in 8-10 ft of water (Hart 1930; Pritchard 1930).

Spawn was also collected in Hay Bay (44°07', 77°01') (Ont. Game Fish 1943); the mouth of the bay was a very good fishing ground during the spawning season (Ont. Game Fish 1913b).

Lake whitefish were not common in the bay except during the fall spawning migration (Hart 1926). Movement into the bay was believed to be through the Upper Gap (44°07', 76°49'), between Indian Point (44°07', 76°51') and Amherst Island (44°09', 76°43'). Tagging studies, however, suggested that more fish moved through the Lower Gap (44°10', 76°35') east of Amherst Island and into the North Channel (44°10', 76°45') (Christie 1954, 1955; Koelz 1929). A gradual movement into the bay from Lake Ontario may have begun as early as August. The adults concentrated in Adolphus Reach (44°07', 76°50') in September and moved upstream in October to spawning grounds. Spawning occurred during a 10-day period in early November, about 2 weeks earlier than lake herring, at water temperatures of 40-50°F. Adults remained in the bay until about February (Christie 1954; Hart 1930; Lapworth 1956; MacKay 1957f; Pritchard 1930, 1931; Rathbun and Wakeham 1897) and then moved slowly down the bay during the winter (Christie 1955).

In 1927-28, fry were collected in rather large numbers beginning in late March at nearshore sites in less than 3 ft of water (Hart 1929, 1930). Young-of-the-year were collected along the north shore of Big Island near Hogs Back, the south shore of Adolphus Reach, and Prinyer Cove (44°05', 76°53') (Dymond et al. 1929; Hart 1930; Hubbs and Brown 1929; Pritchard 1930). In 1974, ten larvae were found in the bay in mid-May (Lam 1977).

During 1940-1960, the spawning population in the Bay of Quinte declined drastically (Christie 1973), and the last strong year class was in 1955 (Christie 1972; GLFC 1979b).

BLOATER

Spawning occurred in Lake Ontario from November to January or March (Koelz 1929; Lagler 1948; Pritchard 1931).

Ontario

OO-1

Winona (43°13', 79°39'). A male with pearl organs was taken off Winona in late November (Koelz 1929).

Port Credit (43°33', 79°35'). A spent female was found off Port Credit in late March (Koelz 1929).

KIYI

The kiyi was commercially important in Lake Ontario during the 1920s and 1930s, but the population is now almost nonexistent (Christie 1973; Scott and Crossman 1973).

No spawning areas were identified. In the 1920s, mature adults were found in New York waters in mid-July. Spent adults were found in early September and spawning was assumed to occur in August (Koelz 1929), September, and October (Pritchard 1928). It was also believed that spawning occurred in December and early January (Pritchard 1931b; Scott and Crossman 1973).

BLACKFIN CISCO

The blackfin cisco was commercially important in Lake Ontario but became extinct by 1900 (Koelz 1926; Scott and Crossman 1923).

No spawning areas were identified. Historically, spawning occurred in New York waters in January, when the fish moved to somewhat shallower water at depths of 240-300 ft (Koelz 1929).

SHORTNOSE CISCO

The shortnose cisco was commercially important in Lake Ontario until the 1940s, but the population is now almost nonexistent (Christie 1973; Scott and Crossman 1973).

No spawning areas were identified, but catches were made during the spawning season in New York waters and off Bronte (43°24', 79°43') and Port Credit (43°33', 79°35'), Ontario (Koelz 1929; Pritchard 1931b; Stone 1944). Spawning occurred in 250 ft of water during April and the first 2 weeks of May. Spent fish were found as early as late January and February but were not common (Koelz 1929; Pritchard 1928, 1931b).

COREGONID spp.

New York

NO-2

Nine Mile Point (43°31', 76°22'). In 1974, among the more abundant larvae collected here in April were those of an unidentified coregonine (LMS 1975b). In 1975, eggs of an unidentified coregonine were entrained here at power plants in late April (LMS 1976b); unidentified coregonine larvae were also collected in the area (PASNY, undated a).

CISCO spp.

Ontario

OO-1

Historically, an unidentified cisco spawned in deep water at the western end of the lake from late December to early February. Few were caught until late fall; catches increased at Niagara (43°15', 79°04'), Bronte (43°24', 79°43'), and Port Credit (43°33', 79°35'), Ontario, in December and were largest in January and February. Some fishermen reported that spawning occurred twice during the year or throughout the year (Kerr and Kerr 1860-1898).

PINK SALMON

Pink salmon were introduced into the Great Lakes when juveniles escaped from a hatchery in 1956 and entered Lake Superior (Parsons 1973); since then the species has spread throughout the Great Lakes.

New York

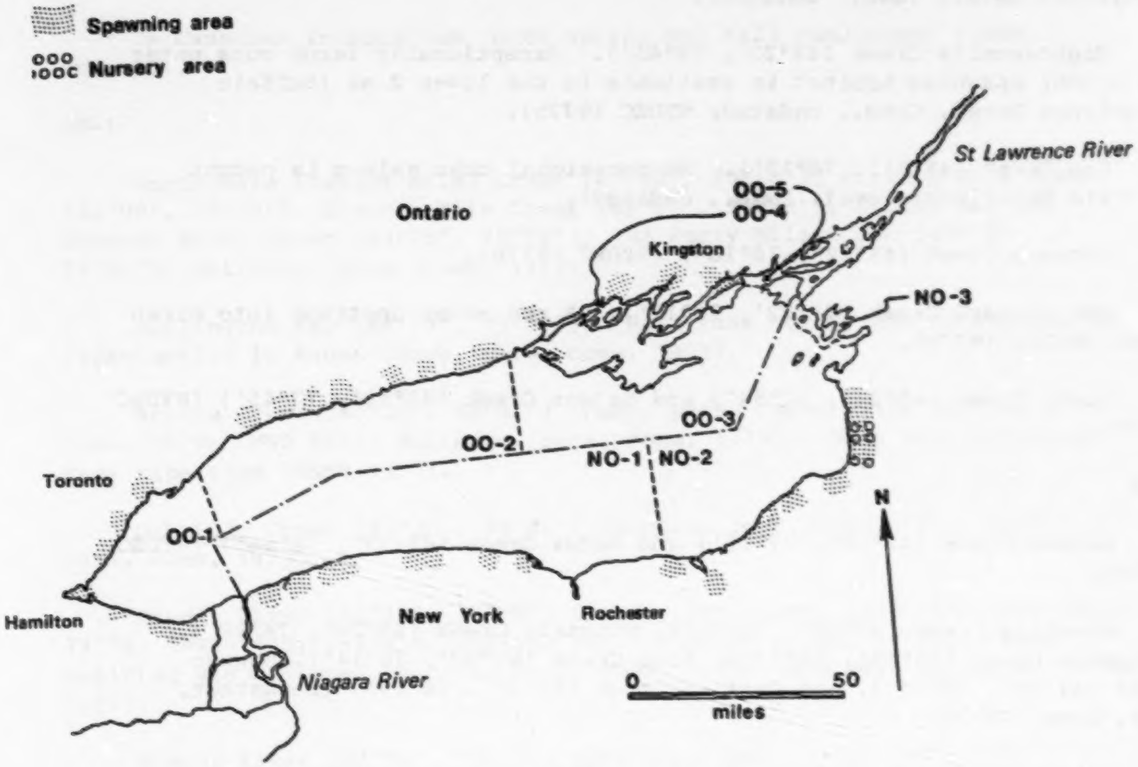
In 1979, there were several sightings of pink salmon in New York tributaries (Schneider, pers. comm. 1979). The species will probably establish runs in all tributaries with mouths not blocked by gravel or sand bars, and successful reproduction may occur (Bergstedt and Elrod, pers. comm. 1979).

Ontario

OO-1

Spencer Creek (43°15', 79°57'). In 1979, 70 spawning pink salmon were seen in Spencer Creek at the head of Burlington Bay in late autumn. This may have been the first sizable run of pink salmon in Canadian waters of Lake Ontario. It is unknown if successful spawning occurred (Whillans, pers. comm. 1979).

COHO


Spawning area
Nursery area
St Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
OO-1
N
Hamilton
New York
Rochester
Niagara River
0
50
miles

Coho salmon were introduced into Lake Ontario in 1919; fry and adults in spawning condition were subsequently caught (Can. Fish. 1924b). Self-sustaining stocks did not become established from this early introduction. Recent plantings began in New York waters in 1968 and in Ontario waters in 1969 (GLFC, in press). Extensive natural reproduction is not expected in Lake Ontario tributaries (Parsons 1973).

New York

In New York waters, any tributary with a sustained flow and a mouth not blocked by gravel or sand bars attracts a spawning run (Bergstedt, pers. comm. 1979). Spawning runs occur in the following areas:

NO-1

Fourmile Creek (43°16', 79°00') and Sixmile Creek (43°17', 78°57') (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Twelvemile Creek (43°19', 78°51'). A fair spawning migration enters the creek (Buffalo Waterfront Devel. Comm., undated).

East Branch Twelvemile Creek (43°19', 78°50'). Coho salmon are present in the creek in the fall and also in the spring (Buffalo Waterfront Devel. Comm., undated).

Eighteenmile Creek (43°20', 78°43'). Exceptionally large runs enter the creek; spawning habitat is available in the lower 2 mi (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Keg Creek (43°21', 78°39'). An occasional coho salmon is caught (Buffalo Waterfront Devel. Comm., undated).

Johnson Creek (43°22', 78°16') (NYDEC 1977b).

Oak Orchard Creek (43°22', 78°12'). A run moves upstream into Marsh Creek (NYDEC 1977b).

Sandy Creek (43°21', 77°54') and Salmon Creek (43°18', 77°45') (NYDEC 1977b).

NO-2

Salmon Creek (43°16', 77°02') and Sodus Creek (43°13', 76°56') (NYDEC 1977b).

Sterling Creek (43°20', 76°41'), Ninemile Creek (43°24', 76°38'), Eightmile Creek (43°25', 76°37'), Rice Creek (43°27', 76°34'), Oswego River (43°28', 76°31'), and Catfish Creek (43°31', 76°19') (Bergstedt, pers. comm. 1979).

Grindstone Creek (43°33', 76°13'). Natural reproduction occurs as far upstream as Spring Brook (NYDEC 1972; SLEOC 1978).

Salmon River (43°34', 76°12'). Runs start as early as August and natural reproduction occurs; redds, ripe fish, and smolts were found (Eckert, pers. comm. 1979; Ringler, pers. comm. 1979; SLEOC 1978). Naturally produced fry were most abundant in Orwell Brook, but were also abundant in other Salmon River tributaries including Pekin, Trout, and John O'Hara brooks (Ringler, pers. comm. 1979).

Little Sandy Creek (43°38', 76°10') (Bergstedt, pers. comm. 1979). Redds, ripe fish, and eggs were found (Eckert, pers. comm. 1979).

Lindsey Creek (43°40', 76°10'). Natural reproduction occurs; young were found in mid-June (Eckert and Panek, pers. comm. 1979).

Skinner Creek (43°41', 76°10') (Bergstedt, pers. comm. 1979; SLEOC 1978). Natural reproduction occurs; young are present in mid-June (Eckert and Panek, pers. comm. 1979).

South Sandy Creek (43°43', 76°12'). Spawning was observed here (Bergstedt, pers. comm. 1979; SLEOC 1978).

Sandy Creek (43°44', 76°12'). Adults were observed entering the creek (Bergstedt, pers. comm. 1979; SLEOC 1978).

Ontario

In Canadian tributaries, both spring and fall runs occur (OMNR, undated).

OO-1

Martindale (Twelve Mile) Creek (43°10', 79°16'), Fifteen Mile Creek (43°09', 79°19'), Sixteen Mile Creek (43°09', 79°20'), Jordan Harbour (Twenty Mile) Creek (43°09', 79°22'), and Forty Mile Creek (43°12', 79°33') (Whillans, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). Fall runs occur, but no successful reproduction is known (Down, pers. comm. 1979).

Bronte Creek (43°24', 79°43') (Down, pers. comm. 1979; Moccia, pers. comm. 1979; OMNR 1973; Whillans, pers. comm. 1979). Eggs were collected from ripe fish (OMNR 1977).

Oakville Creek (43°26', 79°40') (Moccia, pers. comm. 1979; Whillans, pers. comm. 1979).

Credit River (43°33', 79°35') (Down, pers. comm. 1979; Environ. Can. 1977a; OMNR 1973, 1976a,b; Parsons 1973; Tibbles et al. 1976a). Redd building was observed (Moccia, pers. comm. 1979), and were collected (OMNR 1977).

Humber River (43°38', 79°28') (Environ. Can. 1977a; OMNR 1973; Tibbles et al. 1976a).

OO-2

Duffin Creek (43°49', 79°02') (OMNR 1973).

Oshawa Creek (43°52', 78°50'), Farewell Creek (43°52', 78°49'), and Bowmanville Creek (43°54', 78°40') (Whillans, pers. comm. 1979).

Wilmot Creek (43°54', 78°36') (Environ. Can. 1977a; OMNR 1973, 1976a).

Graham Creek (43°54', 78°35') (Environ. Can. 1977a; OMNR 1973).

Ganaraska River (43°57', 78°18') (Environ. Can. 1977a; OMNR 1976a,b; Whillans, pers. comm. 1979).

Cobourg Brook (43°57', 78°11') (Whillans, pers. comm. 1979).

Shelter Valley Creek (43°58', 78°01') (Environ. Can. 1977a; OMNR 1973).

Lakeport Creek (43°59', 77°54'), Loughbreeze Creek (43°59', 77°52'), Salem Creek (44°00', 77°50'), and Spencer Point Creek (44°00', 77°48') (Environ. Can. 1977a).

OO-3

Wellers Bay (44°00', 77°35'). Spawning occurs at the head of the bay (Whillans, pers. comm. 1979).

OO-4

Bay of Quinte (44°08', 77°15'). Spawning runs enter four tributaries and one bay here.

Trent River (44°06', 77°34') (OMNR 1973).

Salmon River (44°11', 77°15') and Napanee River (44°12', 77°01') (Environ. Can. 1977a; OMNR 1973).

Milhaven Creek (44°12', 76°45') (Environ. Can. 1977a; OMNR 1973; Whillans, pers. comm. 1979).

Parrotts Bay (44°12', 76°42') (Whillans, pers. comm. 1979).

KOKANEE

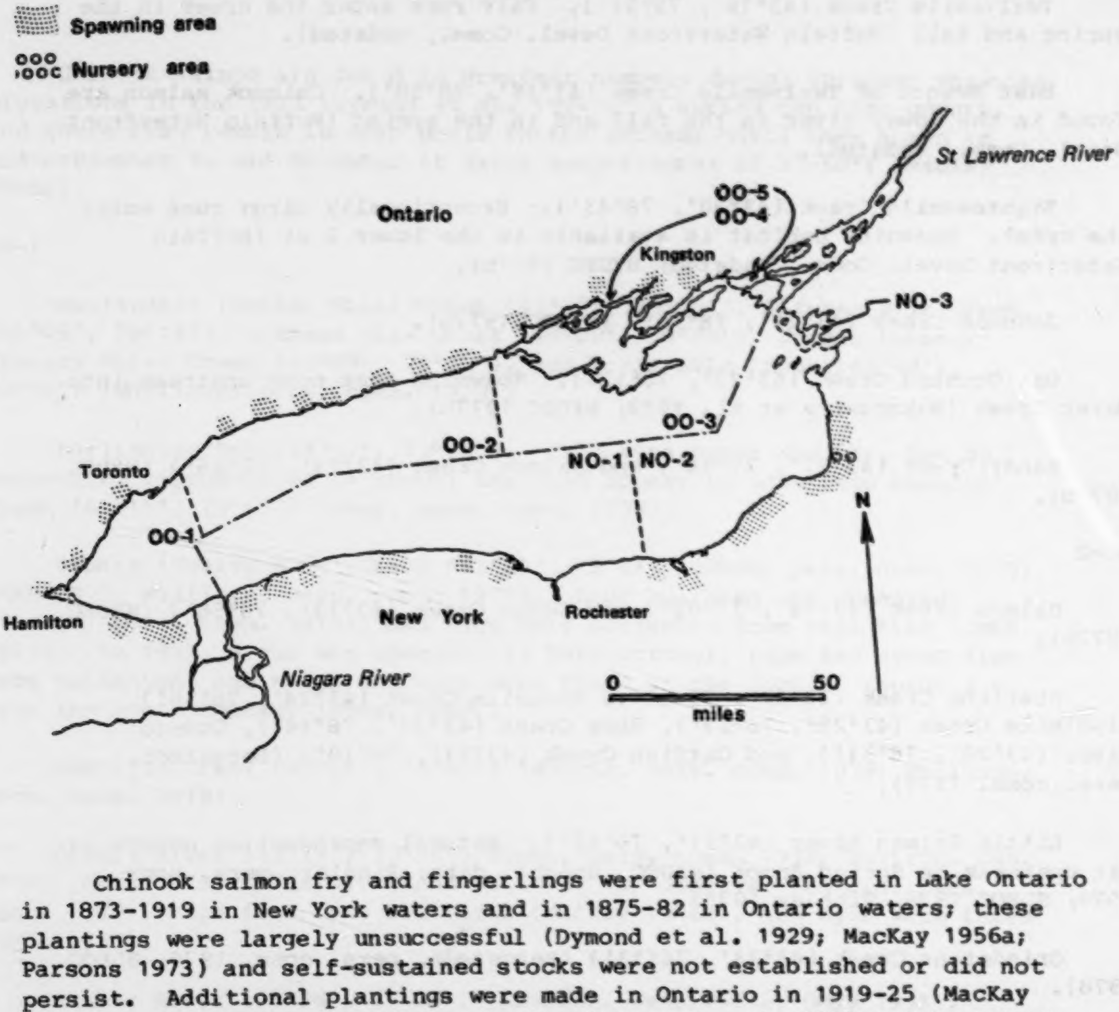
The first introductions of kokanee salmon into the Great Lakes system were made in the Oswego and Black rivers of Lake Ontario in 1950. Many were planted in New York waters since 1950 and in Canadian waters since 1964, but survival was poor (Parsons 1973). Spawning runs occur in the following tributaries:

Ontario

OO-2

Lakeport Creek (43°59', 77°54'), Loughbreeze Creek (43°59', 77°52'), Salem Creek (44°00', 77°50'), and Spencer Point Creek (44°00', 77°48') (Environ. Can. 1977a).

CHINOOK


Spawning area
Nursery area
St Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Hamilton
New York
Rochester
Niagara River
0
50
miles

Chinook salmon fry and fingerlings were first planted in Lake Ontario in 1873-1919 in New York waters and in 1875-82 in Ontario waters; these plantings were largely unsuccessful (Dymond et al. 1929; MacKay 1956a; Parsons 1973) and self-sustained stocks were not established or did not persist. Additional plantings were made in Ontario in 1919-25 (MacKay 1956a). Recent plantings began in New York waters in 1969 and in Ontario waters in 1971 (GLFC, in press). Spawning runs have developed in many tributaries as a result of these recent plantings, but little natural reproduction is reported.

New York

In New York waters, any tributary with a sustained flow and a mouth not blocked by gravel or sand bars attracts a spawning run (Bergstedt, pers. comm. 1979). Spawning runs enter the following tributaries:

NO-1

Fourmile Creek (43°16', 79°00') and Sixmile Creek (43°17', 78°57') (NYDEC 1977b).

Twelvemile Creek (43°19', 78°51'). Fair runs enter the creek in the spring and fall (Buffalo Waterfront Devel. Comm., undated).

East Branch of Twelvemile Creek (43°19', 78°50'). Chinook salmon are found in the lower river in the fall and in the spring (Buffalo Waterfront Devel. Comm., undated).

Eighteenmile Creek (43°20', 78°43'). Exceptionally large runs enter the creek. Spawning habitat is available in the lower 2 mi (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Johnson Creek (43°22', 78°16') (NYDEC 1977b).

Oak Orchard Creek (43°22', 78°12'). Spawning runs move upstream into Marsh Creek (Makarewicz et al. 1979; NYDEC 1977b).

Sandy Creek (43°21', 77°54') and Salmon Creek (43°18', 77°45') (NYDEC 1977b).

NO-2

Salmon Creek (43°16', 77°02') and Sodus Creek (43°13', 76°56') (NYDEC 1977b).

Sterling Creek (43°20', 76°41'), Ninemile Creek (43°24', 76°38'), Eightmile Creek (43°25', 76°37'), Rice Creek (43°27', 76°34'), Oswego River (43°28', 76°31'), and Catfish Creek (43°31', 76°19') (Bergstedt, pers. comm. 1979).

Little Salmon River (43°31', 76°15'). Natural reproduction occurs as far upstream as Spring Brook (NYDEC, unpubl. data; Ringler, pers. comm. 1979; SLEOC 1978; Tibbles 1975).

Grindstone Creek (43°33', 76°13') (Bergstedt, pers. comm. 1979; SLEOC 1978).

Salmon River (43°34', 76°12'). Runs start here as early as August and natural reproduction occurs; redds, ripe fish, and smolts were found in the river (Ringler, pers. comm. 1979; SLEOC 1978). Heavy natural reproduction occurs in Orwell Brook (Ringler, pers. comm. 1979).

Little Sandy Creek (43°38', 76°10') (Bergstedt, pers. comm. 1979).

Skinner Creek (43°41', 76°10') (Bergstedt, pers. comm. 1979; SLEOC 1978).

South Sandy Creek (43°43', 76°12') (Bergstedt, pers. comm. 1979; SLEOC 1978). Redds were found here (Ringler, pers. comm. 1979).

Sandy Creek (43°44', 76°12') (Bergstedt, pers. comm. 1979; SLEOC 1978).

Ontario

Chinook salmon are found in greatest numbers during upstream spawning migrations in the fall (Dymond et al. 1929). A spring run also occurs, and these fish remain in deep pools in the streams until they spawn in mid-September to mid-November at water temperatures of 37-50°F (MacKay 1956a).

OO-1

Martindale (Twelve Mile) Creek (43°10', 79°16'), Fifteen Mile Creek (43°09', 79°19'), Sixteen Mile Creek (43°09', 79°20'), Jordan Harbour (Twenty Mile) Creek (43°09', 79°22'), and Forty Mile Creek (43°12', 79°33') (Whillans, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). Fall runs enter the bay, but no successful reproduction is known; the fish appear to move into Spencer Creek (43°15', 79°57') (Down, pers. comm. 1979).

Bronte (Twelve Mile) Creek (43°24', 79°43') (Down, pers. comm. 1979; OMNR 1973; Whillans, pers. comm. 1979). Redd building was observed (Moccia, pers. comm. 1979), and eggs were collected from ripe fish (OMNR 1977). In 1927, a run was observed in late October, ripe and spent fish were collected, and redds and eggs were found at the foot of rapids 2 mi from the mouth (MacKay 1956a, 1969).

Oakville Creek (43°26', 79°40') (Moccia, pers. comm. 1979; Whillans, pers. comm. 1979).

Credit River (43°33', 79°35') (Down, pers. comm. 1979; Environ. Can. 1977a; OMNR 1973, 1976a,b). Redd building was observed (Moccia, pers. comm. 1979), ripe fish were collected (MacKay 1956a), and eggs were taken (OMNR 1977).

Humber River (43°38', 79°28') (Environ. Can. 1977a; OMNR 1973).

OO-2

Duffin Creek (43°49', 79°02') (Environ. Can. 1977a; OMNR 1973).

Oshawa Creek (43°52', 78°50'), Farewell Creek (43°52', 78°49'), and Bowmanville Creek (43°54', 78°40') (Whillans, pers. comm. 1979).

Wilmot Creek (43°54', 78°36') (Environ. Can. 1977a; OMNR 1973, 1976a,b).

Graham Creek (43°54', 78°35') (Environ. Can. 1977a; OMNR 1973).

Ganaraska River (43°57', 78°18') (Environ. Can. 1977a; Whillans, pers. comm. 1979).

Cobourg Brook (43°57', 78°11') (OMNR 1973).

Shelter Valley Creek (43°58', 78°01') (Environ. Can. 1977a; OMNR 1973).

Lakeport Creek (43°59', 77°54'), Loughbreeze Creek (43°59', 77°52'), Salem Creek (44°00', 77°50'), and Spencer Point Creek (44°00', 77°48') (Environ. Can. 1977a).

OO-4

Bay of Quinte (44°08', 77°15'). In 1921, ripe chinook salmon were caught in the bay in October (MacKay 1956a). Runs enter four tributaries.

> Trent River (44°06', 77°34'), Salmon River (44°11', 77°15'), Napanee River (44°12', 77°01'), and Milhaven Creek (44°12', 76°45') (Environ. Can. 1977a; OMNR 1973).

SALMON spp.

Ontario

OO-3

Bald Head Island (44°00', 77°37'). Unidentified species of salmon spawn along the lake shore here (Environ. Can. 1977a).

Wellington Bay (43°56', 77°21'). Unidentified species of salmon spawn in the bay from the town of Wellington (43°57', 77°21') to West Point (43°53', 77°17') (Environ. Can. 1977a).

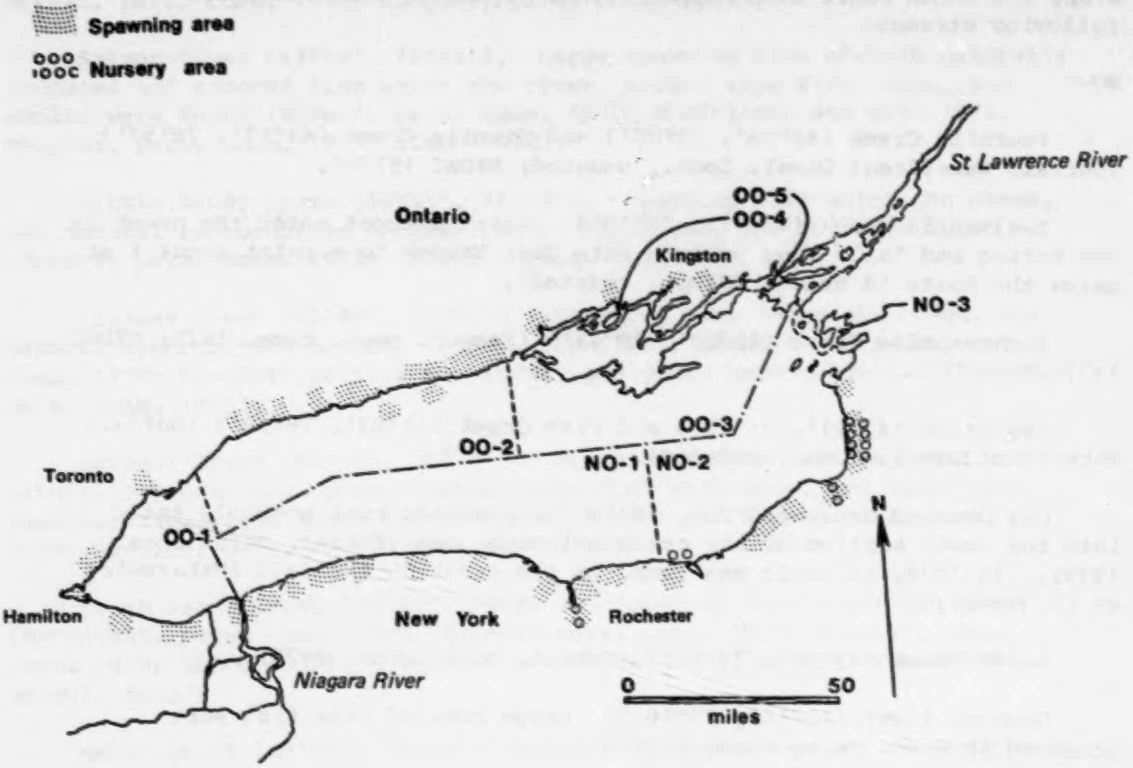
ROUND WHITEFISH

Ontario

OO-2

Raby Head (43°52', 78°43')--Bowmanville (43°54, 78°40'). Spawning occurs in this area (Balesic 1979c). Adults were found inshore in October-December (Balesic 1979a; Dunford 1976) and were ripe by late November. Spawning apparently occurred during the first week of December, when a spent female was collected at a water temperature of about 36°F. Most fish were collected in about 10-30 ft of water. Patches of gravel and rubble in about 10-40 ft of water at Raby Head are good spawning substrate (Dunford 1978c).

RAINBOW TROUT


Spawning area
Nursery area
St Lawrence River
Ontario
OO-5
OO-4
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Hamilton
New York
Rochester
Niagara River
0
50
miles

The initial planting of rainbow trout in the Lake Ontario watershed occurred in the Genesee River, New York, in 1878; by 1884, some of these fish had moved downstream to the lake. The first planting in Lake Ontario proper occurred in 1897 off Grenadier Island (44°03', 76°21'), New York. Plantings by the Province of Ontario began in 1922. Continued stocking of rainbow trout (steelhead) has produced spawning runs in several tributaries of Lake Ontario, but natural reproduction occurs mainly in Canadian tributaries (MacCrimmon and Gots 1972).

New York

In New York waters of Lake Ontario, any tributary with a reasonably sustained flow will attract a run (Bergstedt and Elrod, pers. comm. 1979). Runs start in September or October and continue sporadically through the winter; runs peak mainly in March and April (Bergstedt, pers. comm. 1979;

Eckert and Panek, pers. comm. 1979; Ringler, pers. comm. 1979; SLEOC 1978). Some redds are built in the fall; however, most spawning takes place in the spring (Ringler, pers. comm. 1979). Almost every stream between Oswego (43°28', 76°31') and Stony Point (43°51', 76°18') is fairly good for reproduction (Eckert and Panek, pers. comm. 1979); many others along the south shore also support runs. Spawning runs enter the following streams:

NO-1

Fourmile Creek (43°16', 79°00') and Sixmile Creek (43°17', 78°57') (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Twelvemile Creek (43°19', 78°50'). Rainbow trout enter the creek in the spring and fall; runs proceed into East Branch to a point about 1 mi below the Route 18 bridge (NYDEC, undated).

Eighteenmile Creek (43°20', 78°43') (Eckert, pers. comm. 1979; NYDEC 1977b).

Keg Creek (43°21', 78°39') and Fish Creek (43°22', 78°32') (Buffalo Waterfront Devel. Comm., undated).

Oak Orchard Creek (43°22', 78°12'). Spawning runs probably enter into the lower section of the creek below the dam (Eckert, pers. comm. 1979). In 1978, an adult was found in the creek in the fall (Makarewicz et al. 1979).

Sandy Creek (43°21', 77°54') (Eckert, pers. comm. 1979).

Genesee River (43°15', 77°36'). Large runs of ripe fish were observed (Eckert, pers. comm. 1979).

Irondequoit Creek (43°10', 77°32'). Spawning runs enter the creek and natural reproduction occurs; young have been collected (Eckert, pers. comm. 1979).

Forest Lawn (43°15', 77°30'). An unnamed tributary here supports natural reproduction (NYDEC 1977b).

Fourmile Creek (43°16', 77°26') (NYDEC 1977b).

NO-2

Salmon Creek (43°16', 77°02'). Fall and spring runs enter the creek, and substantial natural reproduction occurs (NYDEC 1977b); the young are probably forced into the lake by high summer stream temperatures (Eckert, pers. comm. 1979).

Sterling Creek (43°20', 76°41'). Spawning runs enter the creek, and natural reproduction occurs (Eckert, pers. comm. 1979).

Oswego River (43°28', 76°31'), Eightmile Creek (43°25', 76°37'), and Ninemile Creek (43°24', 76°38') (Bergstedt, pers. comm. 1979).

Little Salmon River (43°31', 76°15'). Spawning runs enter the river, and natural reproduction occurs; redds, ripe fish, eggs, and smolts were found (Eckert, pers. comm. 1979; Ringler, pers. comm. 1979; SLEOC 1978).

Grindstone Creek (43°33', 76°13') (Bergstedt, pers. comm. 1979; Eckert, pers. comm. 1979; Ringler, pers. comm. 1979).

Salmon River (43°34', 76°12'). Large spawning runs of both naturally produced and stocked fish enter the river; redds, ripe fish, eggs, and smolts were found (Eckert, pers. comm. 1979; MacCrimmon and Gots 1972; Ringler, pers. comm. 1979; SLEOC 1978).

Little Sandy Creek (43°38', 76°10'). Spawning runs enter the creek, and natural reproduction occurs; redds, ripe fish, and YOY were found (Eckert, pers. comm. 1979; NYDEC, unpubl. data).

Lindsey Creek (43°40', 76°10'). Spawning runs enter the creek, and natural reproduction occurs. Redds, ripe fish, (Eckert and Panek, pers. comm. 1979; Ringler, pers. comm. 1979), and young were collected (Eckert, pers. comm. 1979).

Skinner Creek (43°41', 76°10'). Spawning runs enter the creek and natural reproduction occurs; redds, ripe fish with eggs, and young-of-the-year (YOY) were found in the creek (Eckert and Panek, pers. comm. 1979; Ringler, pers. comm. 1979; SLEOC 1978).

South Sandy Creek (43°43', 76°12'). Spawning runs enter the creek (Bergstedt, pers. comm. 1979; Eckert, pers. comm. 1979; Ringler, pers. comm. 1979; SLEOC 1978). Spawning occurs in the Ellisberg area (NYDEC, unpubl. data).

Sandy Creek (43°44', 76°12') (Bergstedt, pers. comm. 1979; MacCrimmon and Gots 1972; SLEOC 1978).

Stony Creek (43°50', 76°14'). Spawning runs enter the creek (NYDEC, unpubl. data); redds were observed (Eckert, pers. comm. 1979).

Ontario

Many Ontario tributaries support spring and fall runs; spawning occurs in April (Christie 1973; OMNR, undated).

OO-1

Niagara River (43°16', 79°04') (MacCrimmon and Gots 1972; OMNR 1973).

Martindale (Twelve Mile) Creek (43°10', 79°16') (MacCrimmon and Gots 1972; Whillans, pers. comm. 1979).

Fifteen Mile Creek (43°09', 79°19'), Sixteen Mile Creek (43°09', 79°20'), Jordan Harbour (Twenty Mile) Creek (43°09', 79°22'), and Forty Mile Creek (43°12', 79°33') (Whillans, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). Fall runs occur, but successful reproduction is doubtful (Down, pers. comm. 1979).

Bronte Creek (43°24', 79°43'). A major spawning run enters the creek (OMNR 1973; Whillans, pers. comm. 1979).

Oakville Creek (43°26', 79°40') (OMNR 1973; Whillans, pers. comm. 1979).

Humber River (43°38', 79°28') (Environ. Can. 1977a; OMNR 1973).

OO-2

Duffin Creek (43°49', 79°02') (Environ. Can. 1977a; OMNR 1973). The east branch supports more spawning than the west branch (Environ. Can. 1977a).

Oshawa Creek (43°52', 78°50') and Farewell Creek (43°52', 78°49') (Whillans, pers. comm. 1979).

Bowmanville Creek (43°54', 78°40') (MacCrimmon and Gots 1972; OMNR 1973; Whillans, pers. comm. 1979).

Soper Brook (43°54', 78°40') (MacCrimmon and Gots 1972; OMNR 1973).

Wilmot Creek (43°54', 78°36'). A major run enters the creek (MacCrimmon and Gots 1972; OMNR 1973, 1976a; Whillans, pers. comm. 1979).

Graham (Newcastle) Creek (43°54', 78°35') (MacCrimmon and Gots 1972; OMNR 1973; Whillans, pers. comm. 1979).

Port Granby (43°54', 78°28'). Spawning occurs about 5 mi off shore at a depth of 36 ft; the substrate is glacial sediment (Balesic 1979c).

Port Britain Creek (43°56', 78°23') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973; Whillans, pers. comm. 1979).

Ganaraska River (43°57', 78°18') (Environ. Can. 1977a; OMNR 1973, 1975, 1976a; Whillans, pers. comm. 1979).

Gage Creek (43°57', 78°16'). A spawning run enters the creek (Environ. Can. 1977a; OMNR 1973). Spawning also occurs in the lake about 1 mi off the creek mouth (Balesic 1979c).

Cobourg Brook (43°57', 78°11') (Whillans, pers. comm. 1979).

Hortop Creek (43°58', 78°03') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Grafton (Prentice) Creek (43°58', 78°02') (MacCrimmon and Gots 1972; Whillans, pers. comm. 1979).

Shelter Valley Creek (43°58', 78°01') (Christie 1973; Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973; Whillans, pers. comm. 1979).

Colborne River and Lakeport Creek (43°59', 77°54') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Salem Creek (44°00', 77°50') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Spencer Point Creek (44°00', 77°48'). Spawning occurs at the creek mouth (Environ. Can. 1977a).

OO-3

Bald Head Beach (44°00', 77°36'). Spawning occurs along the lakeshore at the beach and also around Bald Head Island (44°00', 77°37') (Environ. Can. 1977a).

Wellers Bay (44°00', 77°35'). Spawning occurs along the northwest shore of the bay at 44°02', 77°36' (Environ. Can. 1977a).

OO-4

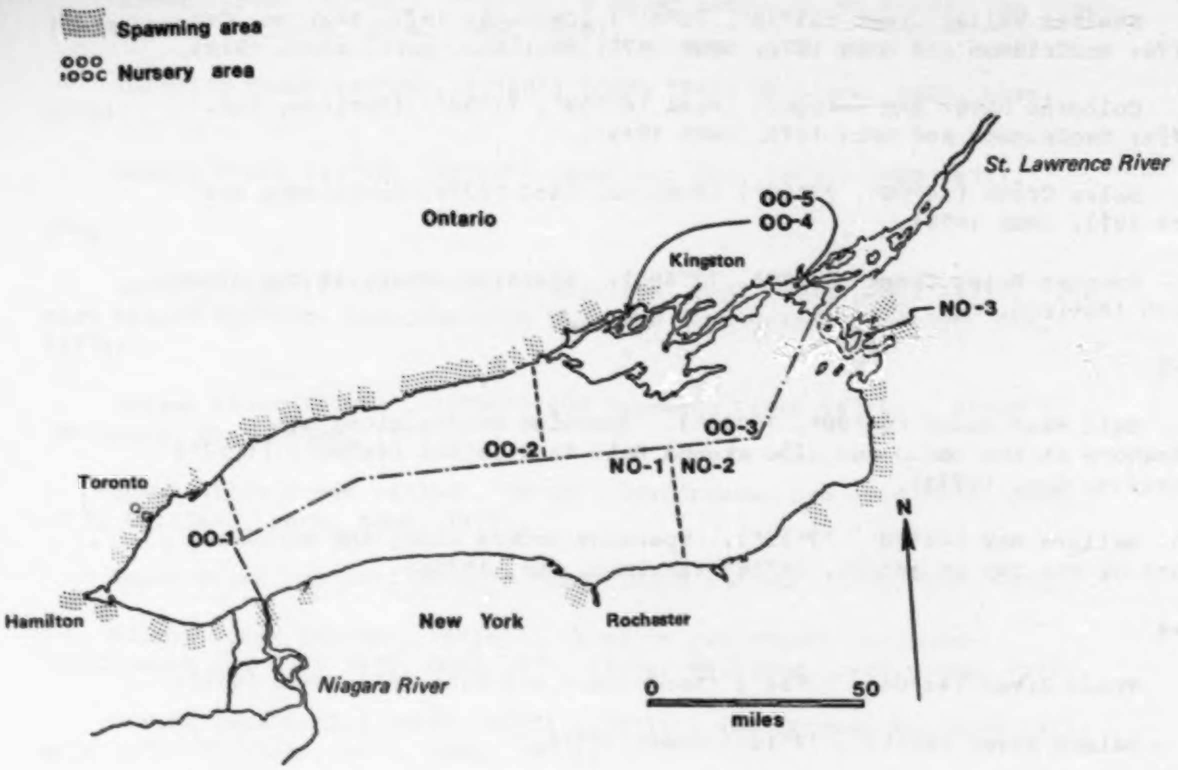
Trent River (44°06', 77°34') (MacCrimmon and Gots 1972; OMNR 1973).

Salmon River (44°11', 77°15') (OMNR 1973).

Napanee River (44°12', 77°01') (Environ. Can. 1977a; MacCrimmon and Gots 1972; OMNR 1973).

Milhaven Creek (44°12', 76°45') (Environ. Can. 1977a; OMNR 1973).

ATLANTIC SALMON


▨ Spawning area
ooo Nursery area
St. Lawrence River
Ontario
OO-5
OO-4
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
OO-1
N
Hamilton
New York
Rochester
Niagara River
0
50
miles

At the time of the earliest settlements on Lake Ontario, a large native landlocked population of Atlantic salmon existed in the lake. These fish entered almost every tributary along both the U.S. and Canadian shores to spawn in the fall (Blair 1938; Kerr and Kerr 1860-1898; McCrimmon 1950, 1951; Skiff et al. 1950; Smith 1892; USDI 1969b). Runs began in October, and spawning began in mid-November. Adults rarely remained in the streams longer than 1 week; none were present in the streams in December (Kerr and Kerr 1860-1898; Parsons 1973).

Runs also occurred during periods of high flow in the summer, notably in the Salmon and Oswego Rivers (Bean 1903; Goode 1884; Kerr and Kerr 1860-1898; Parsons 1973; Smith 1892). Spawning occurred on gravel shoals in clear, cold streams with rather steep gradients (Parsons 1973). Prior to 1850, the Atlantic salmon was the most important species in Lake Ontario (Parsons 1973). Most spawning runs disappeared during 1880-1890, and the last native Atlantic salmon was taken in 1898 (Kerr and Kerr 1860-1898; McCrimmon 1950; Parsons 1973; Smith 1892). The decline of the Lake Ontario stock has been attributed to several factors: the construction of mill dams during the late 1700s and early 1800s that blocked many spawning streams and inhibited reproduction; overfishing during spawning runs, when the salmon were easily netted, clubbed, or speared at stream mouths and below dams; deforestation that resulted in siltation and increased temperatures in spawning streams; and pollution of spawning streams by sawdust, paper-mill waste, and other factory refuse (Bean 1903; Dymond 1964; Edmunds 1874; Edsall 1971; Follett 1932; Kerr and Kerr 1860-1898; OMNR 1973; Parsons 1973; SLEOC 1978; Smith 1892; USBCF 1969a; USDI 1969b).

New York

Plantings in New York waters during 1950-70 failed to re-establish spawning runs (Parsons 1973). Historically, runs occurred in the following New York tributaries.

NO-1

Twelvemile Creek (43°19', 78°51'). Spawning was last seen here in 1880 (Smith 1892).

Sandy Creek (43°21', 77°54') (Parsons 1973).

Genesee River (43°15', 77°36'). The run declined because a high dam was constructed and overfishing occurred below the dam (Edmunds 1874; Follett 1932).

Little Salmon Creek (location uncertain) (Smith 1892).

NO-2

Three-mile Creek (location uncertain) (Parsons 1973).

Oswego River (43°28', 76°31'). Spawning runs were recorded here as early as 1657-1672 (Greeley 1940; Parsons 1973; Skiff et al. 1950; Smith 1892; USDI 1969b). Spawning grounds were at the headwaters of the river in the Finger Lakes (Edmunds 1874; Follett 1932; Parsons 1973). In 1884, the run consisted only of stragglers (Goode 1884) and by 1890, the run ceased (Smith 1892).

Little Salmon River (43°31', 76°15') (Smith 1892).

Grindstone Creek (43°33', 76°13') (Goode 1884; Parsons 1973).

Salmon River (43°34', 76°12'). Spawning runs were recorded here as early as 1657-1672 (Parsons 1973). During 1810-1900, the river supported the best run in U.S. waters; the run proceeded 25-30 mi upstream and supported an important fishery for the settlers of Pulaski. The stock steadily declined after a series of dams was built starting in 1837. In 1890, a few spawners were still found in the river; but by 1900 the run had disappeared (Collins 1885; Edmunds 1874; Follett 1932; Goode 1884; Greeley 1940; Greene 1940; Skiff et al. 1950; Smith 1892; USBCF 1969a;

USDI 1969b). Overfishing, dams, sawdust, and tannery waste contributed to the decline (Goode 1884).

Deer Creek (43°36', 76°10') (Goode 1884; Parsons 1973).

Little Sandy Creek (43°38', 76°10') (Smith 1892).

Sandy Creek (43°44', 76°12'). A run of native fish entered this creek (Parsons 1973; Smith 1892). Spawning runs ceased here long before the 1870s (Edmunds 1874).

Stony Creek (43°50', 76°14'). Historically, a run of native fish entered this creek (Parsons 1973).

NO-3

Black River (44°00', 76°04'). The run was destroyed by impassable dams and acid waste from paper mills (Edmunds 1874; Smith 1892).

Chaumont River (44°04', 76°09'). By the 1870s, the native population here declined due to impassable dams and overfishing (Edmunds 1874). By 1884, the run into Chaumont Bay ceased (Goode 1884).

Ontario

In Canadian waters, Atlantic salmon were found along the beaches in late September prior to the upstream migrations, which occurred in October and November (Huntsman 1944; Kerr and Kerr 1860-1898). Small runs were still occurring in 1879, but most had disappeared by the 1860s (McCrimmon 1950). Artificial propagation and stocking during 1866-1883 failed to restore the population and the last salmon was caught in 1898 (OMNR 1973). Stocking during the 1940s also failed (McCrimmon 1950, 1951; Parsons 1973). Historical runs occurred in the following tributaries:

OO-1

Niagara River (43°16', 79°04'). Spawning runs occurred here (OMNR 1973), although spawning grounds below the falls were scarce (Parsons 1973).

Martindale (Twelve Mile) Creek (43°10', 79°16') and Jordan Harbour (Twenty Mile) Creek (43°09', 79°22') (OMNR 1973; Parsons 1973). By 1873, the spawning runs were almost extinct because fish were destroyed on spawning grounds (Kerr and Kerr 1860-1898).

Forty Mile Creek (43°12', 79°33') (OMNR 1973).

Burlington Bay (43°17', 79°50'). Until 1885, substantial spawning runs moved through the bay and into Redhill Creek (43°15', 79°46'), Dundas Creek (43°16', 79°56') (Kerr and Kerr 1860-1898; Whillans 1977), and Grindstone Creek (43°17', 79°53') (Parsons 1973).

Bronte Creek (43°24', 79°43') and Oakville Creek (43°26', 79°40') (OMNR 1973; Parsons 1973).

Credit River (43°33', 79°35'). The Credit River supported the largest run in the lake (Follett 1932; OMNR 1973; Parsons 1973); spawning occurred around November 10-20 (Kerr and Kerr 1860-1898). The river was also a major nursery area (Ricker 1964). Runs were recorded until 1878 (Kerr and Kerr 1860-1898; Parsons 1973); the decline was attributed to overfishing and to siltation following deforestation (Follett 1932) and to dams that blocked spawning migrations (Ricker 1964).

Cooksville Creek (43°34', 79°34') and Etobicoke Creek (43°35', 79°33') (OMNR 1973).

Garrison Creek (location uncertain) (Parsons 1973).

Mimico Creek (43°37', 79°29') (OMNR 1973). By 1873, the spawning runs had almost ceased because fish were destroyed on the spawning grounds (Kerr and Kerr 1860-1898).

Humber River (43°38', 79°28'). During the 1790s-1876, Atlantic salmon migrated upstream to spawn on the rapids; this run declined by 1845 (Fox 1930; Kerr and Kerr 1860-1898; OMNR 1973; Parsons 1973; Whillans 1977).

Don River (43°39', 79°21'). Atlantic salmon migrated through Toronto Bay (43°38', 79°23') to spawn in the river. The run declined by 1829, although fish were still being speared on the spawning beds in early November 1873 (Follett 1932; Fox 1930; Kerr and Kerr 1860-1898; OMNR 1973; Whillans 1977).

OO-2

Highland Creek (43°46', 79°10'). A decline in the run was noted in 1881 (Kerr and Kerr 1860-1898); stocking did not re-establish the run (Parsons 1973).

Rouge River (43°48', 79°07'). Spawning occurred on the rapids until 1882 (Huntsman 1944; Kerr and Kerr 1860-1898; OMNR 1973; Parsons 1973).

Petticoat Creek (43°08', 79°06'). The run was destroyed because stream flow was reduced (Kerr and Kerr 1860-1898).

Duffin Creek (43°49', 79°02'). Runs were recorded until 1882; this was one of the better Atlantic salmon streams and one of the last streams to support runs of native Atlantic salmon. Adults began moving into the creek and to the rapids around October 15, spawned until mid-November, and were gone by the end of November. Stocking during 1944-48 did not re-establish the run, although in 1950 a ripe female returned in the fall (Huntsman 1944; Kerr and Kerr 1860-1898; McCrimmon 1950, 1951, 1954; OMNR 1973; Ricker 1964; Smith 1978c).

Lynde Creek (43°51', 78°57'). Runs were recorded until 1878 (Kerr and Kerr 1860-1898; OMNR 1973; Parsons 1973).

Pringle Creek (43°52', 78°56') and Oshawa Creek (43°52', 78°50') (OMNR 1973).

Farewell Creek (43°52', 78°49') (OMNR 1973; Parsons 1973).

Bowmanville Creek (43°54', 78°40') (OMNR 1973).

Soper Creek (43°54', 78°40') (OMNR 1973; Parsons 1973).

Wilmot Creek (43°54', 78°36'). Many salmon entered the creek in October; by 1866 the run was declining (Follett 1932; Moenig, undated; OMNR 1973; Parsons 1973; Smith 1892).

Graham Creek (43°54', 78°35') and Port Britain Creek (43°56', 78°23') (OMNR 1973).

Ganaraska River (43°57', 78°18') (OMNR 1973; Parsons 1973). The stream historically supported many Atlantic salmon; the population declined, probably because the river was blocked by dams. The first dam was built in 1799, and by 1861 there were 36 dams on the creek (Richardson 1946).

Gage Creek (43°57', 78°16') and Cobourg Brook (43°57', 78°11') (OMNR 1973; Parsons 1973). Spawning runs moved upstream in Cobourg Brook into Percy Creek (OMNR 1973).

Brookroad Creek (43°57', 78°07'), Livingstone Creek (43°58', 78°05'), and Hortop Creek (43°58', 78°03') (OMNR 1973).

Grafton Creek (43°58', 78°02') (Huntsman 1944).

Shelter Valley Creek (43°58', 78°01') (OMNR 1973; Parsons 1973).

Colborne River (43°59', 77°54') and Salem Creek (44°00', 77°50') (OMNR 1973).

OO-3

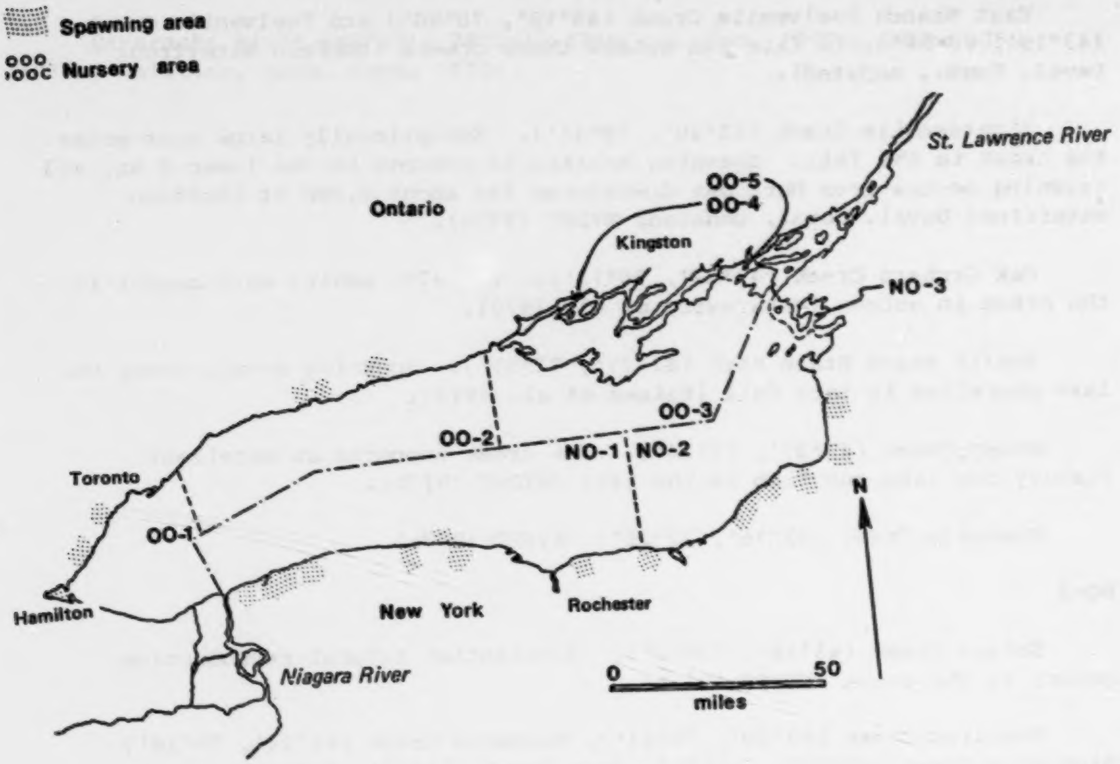
Butler Creek (44°02', 77°43') (OMNR 1973).

OO-4

Bay of Quinte (44°08', 77°15'). Many tributaries supported spawning runs (Follett 1932), but only three were identified:

Trent River (44°06', 77°34'), Moira River (44°09', 77°23'), and Salmon River (44°11', 77°15') (Parsons 1973).

BROWN TROUT


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Hamilton
New York
Rochester
Niagara River
0
50
miles

The brown trout, a native of Europe and western Asia, was introduced into the United States in about 1883 and subsequently entered the Great Lakes, probably from stream stockings (Moffett 1958; Scott and Crossman 1973). Plantings in Lake Ontario and its tributaries have produced spawning runs in several streams.

New York

In New York waters of Lake Ontario, any tributary with a reasonably sustained flow and a mouth not blocked by gravel or sand bars will attract a run (Bergstedt, pers. comm. 1979). In the fall, many fish move from the lake into stream mouths, but it is not known if these fish spawn successfully. Spawning is also believed to occur on rocky areas in the lake proper (Eckert, pers. comm. 1979). Spawning runs occur in the following areas:

NO-1

Fourmile Creek (43°16', 79°00') and Sixmile Creek (43°17', 78°57'). Spawning runs enter these creeks in the fall (NYDEC 1977b).

East Branch Twelvemile Creek (43°19', 78°50') and Twelvemile Creek (43°19', 78°51'). A fair run enters these creeks (Buffalo Waterfront Devel. Comm., undated).

Eighteenmile Creek (43°20', 78°43'). Exceptionally large runs enter the creek in the fall. Spawning habitat is present in the lower 2 mi, and spawning occurs from Burt Dam downstream for about 1,000 ft (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Oak Orchard Creek (43°22', 78°12'). In 1978, adults were caught in the creek in autumn (Makarewicz et al. 1979).

Hamlin Beach State Park (43°21', 77°57'). Spawning occurs along the lake shoreline in late fall (Haines et al. 1977).

Sandy Creek (43°21', 77°54'). The creek supports an excellent fishery for lake-run fish in the fall (NYDEC 1977b).

Fourmile Creek (43°16', 77°26') (NYDEC 1977b).

NO-2

Salmon Creek (43°16', 77°02'). Substantial natural reproduction occurs in the creek (NYDEC 1977b).

Sterling Creek (43°20', 76°41'), Ninemile Creek (43°24', 76°38'), Eightmile Creek (43°25', 76°37'), Rice Creek (43°27', 76°34'), Oswego River (43°28', 76°31'), Catfish Creek (43°31', 76°19'), Grindstone Creek (43°33', 76°13'), and South Sandy Creek (43°43', 76°12') (Bergstedt and Elrod, pers. comm. 1979).

Sandy Creek (43°44', 76°12') (Bergstedt, pers. comm. 1979; Eckert, pers. comm. 1979).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). A minor run enters the bay in October, but reproduction is not known to be successful (Down, pers. comm. 1979).

Bronte Creek (43°24', 79°43'), Oakville Creek (43°26', 79°40'), and Credit River (43°33', 79°35'). Minor runs occur (Moccia, pers. comm. 1979).

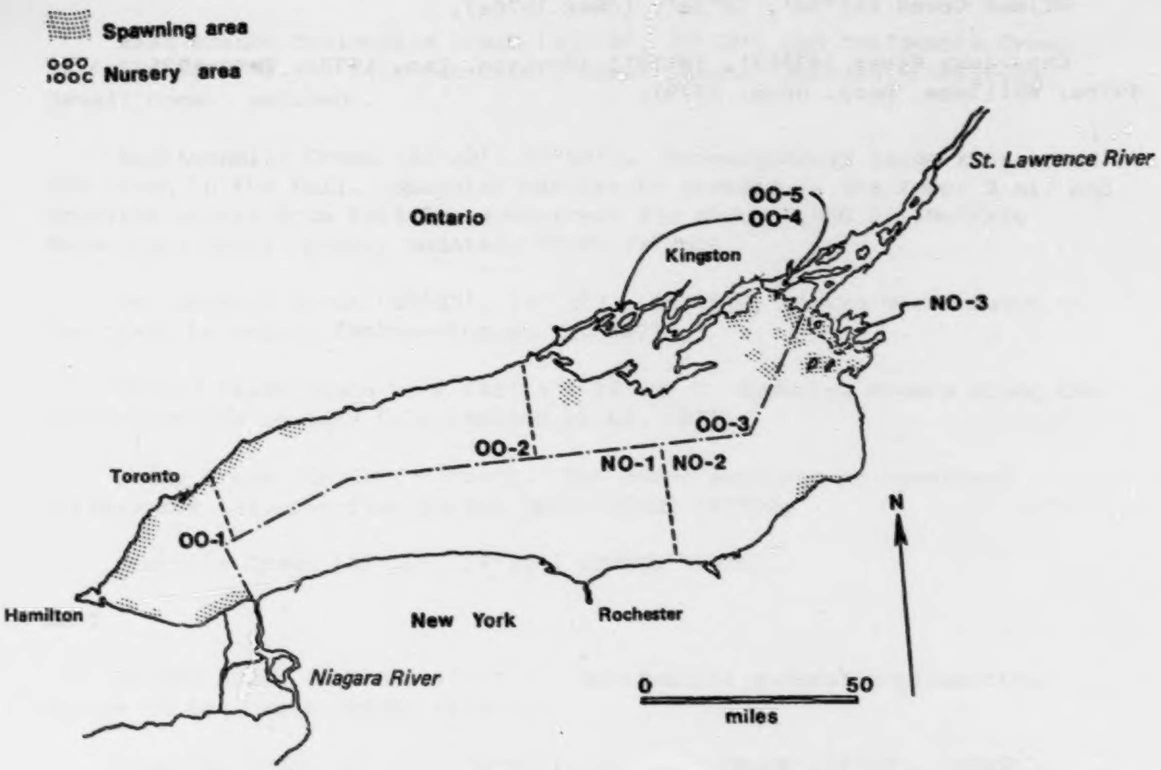
OO-2

Bowmanville Creek (43°54', 78°40') (Whillans, pers. comm. 1979).

Wilmot Creek (43°54', 78°36') (OMNR 1976a).

Ganaraska River (43°57', 78°18') (Environ. Can. 1977a; OMNR 1975, 1976a; Whillans, pers. comm. 1979).

LAKE TROUT


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
OO-1
N
Hamilton
New York
Rochester
Niagara River
0
50
miles

Historically, native lake trout spawned in Lake Ontario from October to mid-November or December on reefs at depths of 10-100 ft, at the same sites used by lake whitefish (Cahill, pers. comm. 1977; Nash 1913; Rathbun and Wakeham 1897; Smith 1892). Most of the spawning grounds were concentrated in the eastern end of the lake in Canadian waters (Cahill, pers. comm. 1977; Goode 1884; Pasko 1956; USBCF 1969a; USDI 1969b). Historical records from the National Fish Hatchery at Cape Vincent show that lake trout eggs were collected from fish captured in shallow water from mid-October to early November in eastern Lake Ontario (Schneider, pers. comm. 1980). By the late 1800s, only a few fish were moving to shoreline areas to spawn (Smith 1892). In 1940, lake trout spawn was still being collected by the Cape Vincent Station (Leach et al. 1941). By 1950, the population had declined almost to extinction (Christie 1973). Lake trout have been stocked in Lake Ontario since 1972 (Crossman and Van Meter 1979; GLFC, in press). No natural reproduction has been recorded since the 1950s. In the fall of 1979, fish of hatchery origin spawned along the eastern shore in New York waters.

New York

NO-2

Nine Mile Point (43°31', 76°22'). In 1978, a few ripe and gravid adults were collected off the point in mid-September, and a spent adult was found west of the point near Oswego (43°28', 76°31') (Eckert and Schneider, pers. comm. 1979).

Snow Shoe Bay (43°53', 76°14'). In 1979, spawning was documented on a gravel shelf 8 ft deep on the lake side of the bay on November 14 and 15 at a water temperature of 51°F. Spawning was observed by divers, and eggs were found on the bottom (Eckert and Schneider, pers. comm. 1979; Sly, pers. comm. 1979).

Stony Island (43°54', 76°20'). This was a major historical ground (Cahill, pers. comm. 1977; Eckert and Schneider, pers. comm. 1979; Pasko 1956; Redband 1912; Smith and Snell 1891). In 1978, eggs were stripped from ripe fish collected off the north tip of the island (Eckert and Schneider, pers. comm. 1979; Sly, pers. comm. 1979).

Calf Island Shoal (43°52', 76°22'). This was an historical spawning ground; plantings were recently made here (GLFC 1975, 1976a).

Galloo Island (43°54', 76°25'). This was an historical spawning ground (Pasko 1956; Smith and Snell 1891).

Allan Otty Shoal (44°04', 76°27'). This was an historical spawning ground (Eckert and Schneider, pers. comm. 1979).

NO-3

Horse Island (43°57', 76°09'). Historically, this was a favorite spawning site. Fishermen believed that spawning stopped here because alewives died in large numbers on the spawning grounds (Smith and Snell 1891).

Point Peninsula (44°00', 76°15'). Historically, spawning occurred here on most of the shallow points (Cahill, pers. comm. 1979).

Grenadier Island (44°03', 76°21'). This was an historical spawning ground (Eckert and Schneider, pers. comm. 1979).

Ontario

OO-1

In western Lake Ontario, lake trout began to move from deep water on about September 1 (Kerr and Kerr 1860-1898).

Niagara (43°16', 79°04')--Winona (43°13', 79°39'). Historical spawning grounds were located at Winona and Grimsby (43°12', 79°34'), and along almost the entire shoreline from Niagara to Twenty Mile Creek (43°09', 79°22') (Kerr and Kerr 1860-1898).

Bronte (43°24', 79°43')--Port Credit (43°33', 79°35'). Spawning occurred on shoals off Bronte, Oakville (43°26', 79°40'), Clarkson (43°30', 79°37'), and Port Credit at depths of about 13-16 ft (Kerr and Kerr 1860-1898; Ont. Game Fish 1913b; Ruple 1978; Whillans 1977). At Port Credit, lake trout spawned on two shoals 1/4 mi off shore. Peel County, which includes Clarkson and Port Credit, had the most important lake trout fishery in the western part of Lake Ontario; fish were caught here in September and October (Ruple 1978). A new, man-made shoal at Clarkson, just off the Gulf Oil Refinery (Ruple 1978), is composed of large boulders to a depth of 35 ft and is a potential spawning ground (Sly, pers. comm. 1979).

Toronto (43°38', 79°25'). Historically, spawning occurred south of the eastern gap of the Toronto Islands (43°38', 79°20'), off the foot of Church Street, southeast of Ashbridges Bay (43°40', 79°19'), and off Scarborough Bluffs (43°43', 79°14') (Kerr and Kerr 1860-1898; Ruple 1978; Whillans 1977). Spawning declined at Toronto in the 1870s. "Stone hooking," removal of rock from the bottom for use as building material, occurred during 1830-1930 and probably severely altered spawning grounds at Toronto and along the entire shore from Burlington (43°21', 79°46') to Whitby (43°51', 78°56') (Ruple 1978; Whillans 1979b). "Trout" grounds were also almost destroyed by oil and tar materials dredged out of Toronto Bay (43°38', 79°23') and dumped in the lake (Ont. Game Fish 1912).

OO-2

Frenchman Bay (43°49', 79°06'). Spawning occurred at the mouth of the bay; lake trout taken here were full of spawn from September 1 to October 30 (Kerr and Kerr 1860-1898).

Whitby (43°51', 78°56'). Spawning occurred on reefs here and also at Shoal Point (location unknown) (Kerr and Kerr 1860-1898; Whillans 1977).

OO-3

Prince Edward County Peninsula (44°00', 77°15'). Historical spawning areas existed off the south shore; these included Nicholson Island (43°55', 77°31') and Scotch Bonnet Island (43°54', 77°33') (Christie 1973; Sly, pers. comm. 1979).

Main Duck Island (43°56', 76°37'). This was a major historical spawning ground. Yorkshire Bar (43°56', 76°35') was an especially important area; plantings were made here during the 1970s (Christie 1973; Eckert and Schneider, pers. comm. 1979; GLFC 1975; Pasko 1956; Ruple 1978; Sly, pers. comm. 1979).

Amherst Island (44°09', 76°43'). This was an historical spawning area (Cahill, pers. comm. 1977; Eckert and Schneider, pers. comm. 1979).

Big Bar Shoal (44°04', 76°44'). This was an historical spawning area (Eckert and Schneider, pers. comm. 1979).

Simcoe Island (44°10', 76°32'). This was a major historical ground; lake trout eggs were taken here for the National Fish Hatchery (Eckert and Schneider, pers. comm. 1979).

Wolfe Island (44°10', 76°25'). Long Point (44°06', 76°29') was an historical spawning ground (Eckert and Schneider, pers. comm. 1979).

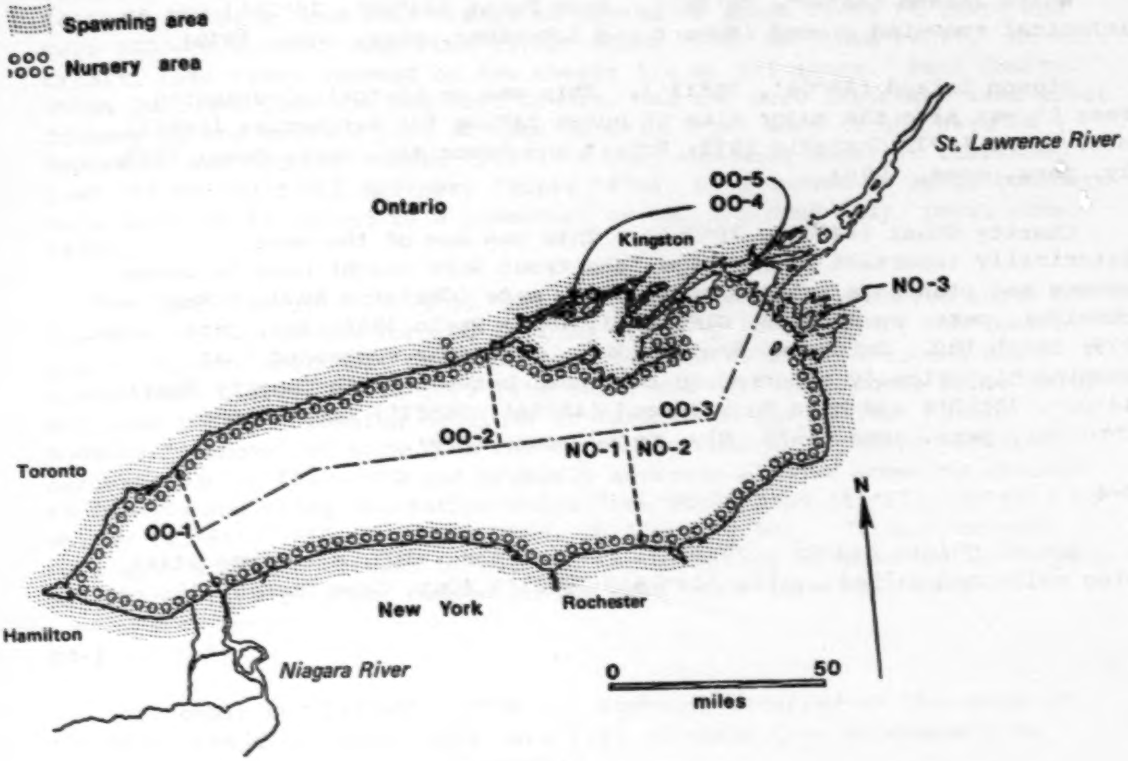
Pigeon Island (44°04', 76°33'). This was an historical spawning area; it was also the major site of spawn taking for hatcheries (Cahill, pers. comm. 1977; Christie 1973; Eckert and Schneider, pers. comm. 1979; Sly, pers. comm. 1979).

Charity Shoal (44°03', 76°29'). This was one of the most historically important reefs; ripe lake trout were caught here in large numbers and plantings are presently being made (Christie 1973; Eckert and Schneider, pers. comm. 1979; GLFC 1973, 1975; Pasko 1956; Sly, pers. comm. 1979; Smith 1892; Smith and Snell 1891). Fishermen suggested that spawning historically occurred on the shoal between South Charity Shoal (44°02', 76°30') and Main Duck Island (43°56', 76°37') (Eckert and Schneider, pers. comm. 1979; Sly, pers. comm. 1979).

OO-4

Bay of Quinte (44°08', 77°15'). During the 1930s, spawn was still being collected at Belleville (44°09', 77°23') (Ont. Game Fish 1933).

RAINBOW SMELT


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Hamilton
New York
Rochester
Niagara River
0
50
miles

The first records for rainbow smelt in Lake Ontario were established in 1929 at Sodus Point, New York (Greeley 1929), and in 1931 at Bowmanville, Ontario (Mason 1933). These fish probably originated from plantings in New York waters (Christie 1973; Scott and Crossman 1973). Runs developed in several streams along the U.S. and Canadian shores after 1940 (Van Oosten 1948); by 1942, sportsmen had begun to fish the runs (SLEOC 1978), and they are still heavily fished (USBCF 1969a).

Every tributary with a mouth not blocked by gravel or sand bars supports a run, usually in April. Spawning also occurs on rocky or sandy shoals and points throughout the lake proper in late April (Eckert and Schneider, pers. comm. 1979; Scott 1967; Slastenenko 1957). Runs usually occur at water temperatures of 40-65°F (Niagara Mohawk Power, undated a; USDI 1969b). In years when some of the mouths of smaller tributaries are blocked by sand or gravel, lake spawning may be more important (Eckert, pers. comm. 1979). The nearshore waters of the entire lake are nursery habitat (Schneider, pers. comm. 1979; Werner and Ford 1972).

New York

NO-1

Niagara Bar (43°17', 79°05'). Many young-of-the-year (YOY) were collected here (Schneider, pers. comm. 1979).

Braddock Bay (43°19', 77°43'). Good spawning runs occur here in the early spring (N.Y. State Dep. Conserv., undated c).

Russell Power Station (43°16', 77°38'). In 1977, smelt larvae dominated collections here in June (Bio Systems 1978b).

Irondequoit Bay (43°14', 77°32'). Smelt spawn on the lake shores near the bay; in 1977, adults were collected nearshore from mid-April to mid-May (Haines et al. 1977).

Ginna Power Station (43°17', 77°18'). In 1977, 86% of the larvae caught in early June were rainbow smelt (Bio Systems 1978a).

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1974, the dominant larvae collected in May were rainbow smelt; these had probably drifted into the area from nearby streams, where spawning occurred in early April to mid-May (LOTEL 1977). In 1977, eggs were collected in early May, and larvae were collected out to the 46 ft contour from mid-May to September; rainbow smelt were the dominant larvae in the area in June (Rochester Gas Elec. 1977).

Oswego (43°28', 76°31'). Adults were most abundant in the area and were impinged in greatest numbers at the Oswego Steam Station in April and May (LMS 1976a, 1977b; Niagara Mohawk Power, undated b,c). Eggs were collected in the area and entrained at the station from early April to late June (LMS 1977b; NMPC, undated b,c). Larvae were found as early as mid-March (LMS 1977b) and were present throughout the summer (LMS 1976a; Niagara Mohawk Power, undated b,c).

Nine Mile Point (43°31', 76°22'). Most adults are collected in the area from March to May during the inshore migration (LMS 1975a,b, 1976b; PASNY, undated a,b). Spawning occurs in April (LMS 1975b; PASNY, undated a). Eggs were collected from April 10 to June 18 (LMS 1975b, 1976b; PASNY, undated a,b). Larvae and YOY are very abundant (QLM Engineers 1974). Larvae appeared in early April and were present near shore and off shore throughout the spring and summer (LMS 1975b, 1976b; PASNY, undated a,b; QLM 1974). Young-of-the-year first appeared in June (PASNY, undated b).

Grindstone Creek (43°33', 76°13'). (Eckert, pers. comm. 1979).

Salmon River (43°34', 76°12'). A spawning run occurs in April and May (Eckert, pers. comm. 1979; SLEOC 1978).

NO-3

Black River (44°00', 76°04'). Rainbow smelt enter Black River Bay (43°59', 76°05') and the river in April and May (Eckert, pers. comm. 1979; SLEOC 1978).

Tibbets Point (44°06', 76°22'). The spawning run begins at a water temperature of 44°F; running ripe adults are collected on the shoals around the point (Eckert, pers. comm. 1979).

Ontario

In Canadian waters, rainbow smelt runs usually begin when the ice breaks up. In southern Ontario, tributary runs occur in late March-early May; in more northern areas, runs occur in April and continue for about 3 weeks. Spawning also occurs along the lake shore (MacKay 1958a). Commercial fishermen report that a "jumbo" smelt spawns at depths of 80 ft or more 1-1/2 to 5 mi off shore (Balesic 1979c). Along the north shore, larvae are concentrated inshore in May and June just after hatching, but disperse rapidly to deeper water after they become demersal (Dunstall 1979a,b).

OO-1

Welland Canal (43°13', 79°13'). Smelt enter the canal and spawn over gravel in April and May (Moccia, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). Since 1950, smelt have spawned in Dundas Creek (43°16', 79°56') and also in the northwest corner of the bay (Whillans 1977). Spawning also occurs on Hamilton Beach (43°17', 79°47') (Moccia, pers. comm. 1979). In 1958, the run in Burlington Canal (43°18', 79°48') occurred in late March-early May; it began at a water temperature of 38°F and peaked April 18-24 at 46-48°F (Wolfe 1958, 1959).

Credit River (43°33', 79°35') and Etobicoke Creek (43°35', 79°33'). Spawning occurs at the mouths of these streams (Environ. Can. 1977a).

Toronto (43°38', 79°25'). In 1954, a spawning run entered Toronto Bay (43°38', 79°23'); spawning may have occurred in the Outer Harbour (43°38', 79°20') (Wainio et al. 1973; Whillans 1977). Runs entered the discharge canal of the R. L. Hearn Generating Station (43°39', 79°20') at the same time that runs entered nearby streams and moved onto beaches in the area (Everest 1973).

OO-2

Rouge River (43°48', 79°07'). Spawning occurs at the river mouth (Environ. Can. 1977a).

Duffin Creek (43°49', 79°02'). In 1977, ripe adults were taken at the creek mouth on April 25 (Griffiths 1978a).

Pickering Generating Station (43°48', 79°04'). Eggs were collected at the station in mid-May and in the lake in early June (Dunstall 1978b). Early postlarvae were collected from late May through July; there appeared to be a concentration of these larvae on the east side of the intake groin (Dunford 1977; Dunstall 1978b). Young-of-the-year were entrained at the station in early August (Dunstall 1978b). In 1978, one of the areas of high larval density was at this station (Dunstall 1979a).

Darlington Generating Station (43°52', 78°43') and Wesleyville Generating Station (43°55', 78°25'). Spawning occurs near shore in these areas (Dunford 1979).

Graham Creek (43°54', 78°35'), Port Britain Creek (43°56', 78°23'), Ganaraska River (43°57', 78°18'), Gage Creek (43°57', 78°16'), Cobourg Brook (43°57', 78°11'), and Hortop Creek (43°58', 78°03'). Spawning occurs at the mouths of these streams (Environ. Can. 1977a).

Shelter Valley Creek (43°58', 78°01'). A spawning run begins in about the second week of April at a water temperature of 40°F and extends into early May. Spawning occurs over gravel in 1-2 ft of clear, slowly flowing water. Young-of-the-year were collected in the creek (Chen 1970).

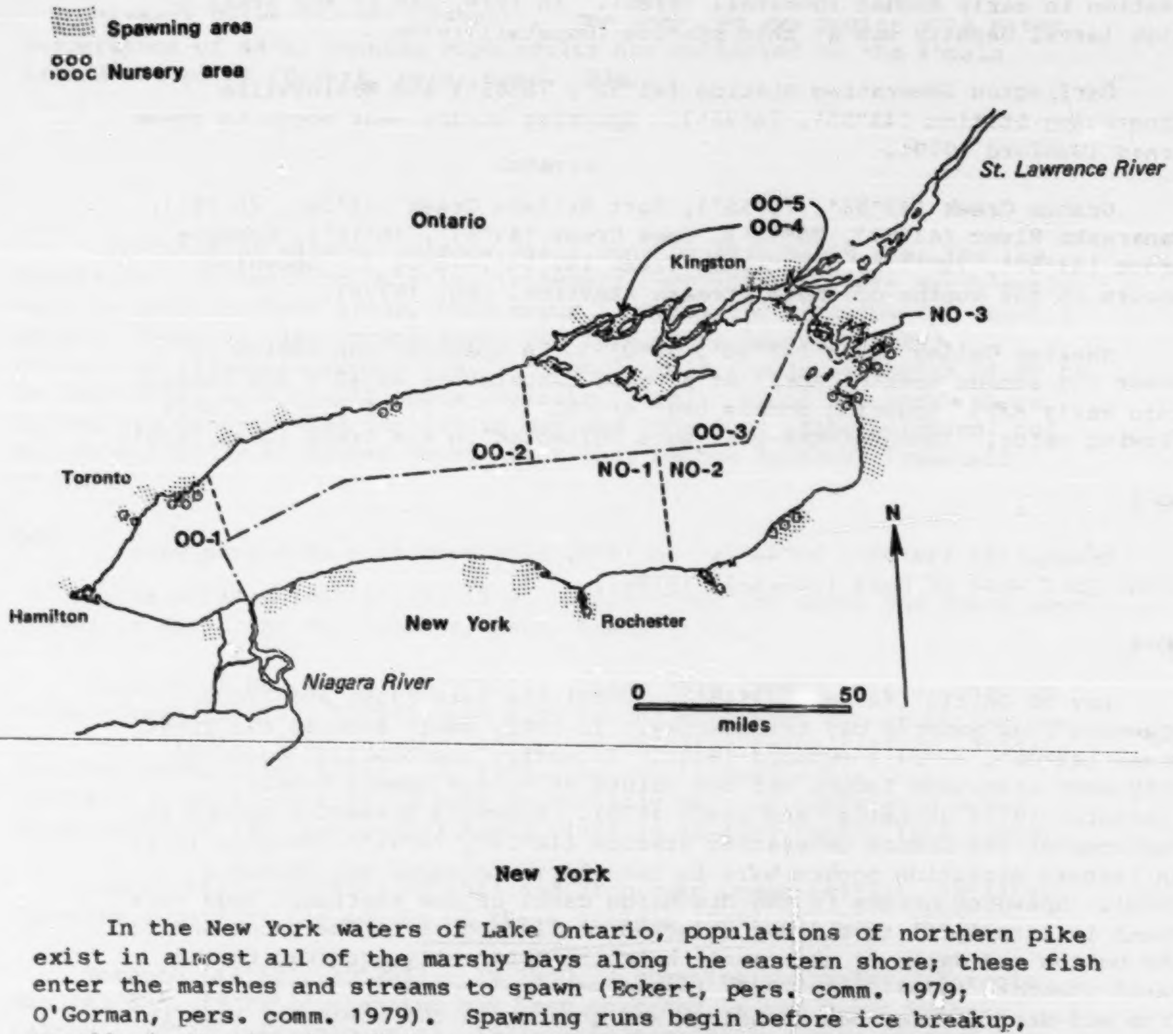
OO-3

Presqu'ile (44°00', 77°44'). In 1978, high densities of larvae were found just west of here (Dunstall 1979a).

OO-4

Bay of Quinte (44°08', 77°15'). Until the late 1950s and 1960s, spawning runs entered bay tributaries. In 1942, smelt entered the Trent River (44°06', 77°34') (Dymond 1944). Recently, reproduction occurred only over limestone ledges off the points of Prince Edward County (Christie 1972; Schneider and Leach 1979). Spawning presently occurs in the area of the Lennox Generating Station (44°09', 76°51') (Dunford 1979); an inshore migration occurs here in late April to early May (Balesic 1978). Spawning occurs in the discharge canal of the station. Eggs were found in late April to mid-May attached to Cladophora in the canal and to the bottom and walls of the canal; hatching apparently occurred in the canal (Dunford 1978a). In 1974, larvae were collected throughout the bay from mid-May to June, but abundance was greater in the lower bay than in other locations (Lam 1977). Larvae were widely distributed in all areas around the Lennox Station from May to early August; highest densities occurred just east of the station at Pig Point (44°08', 76°49') (Dunford 1978a; Griffiths 1976b).

NORTHERN PIKE


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
OO-1
N
Hamilton
New York
Rochester
Niagara River
0
50
miles

New York

In the New York waters of Lake Ontario, populations of northern pike exist in almost all of the marshy bays along the eastern shore; these fish enter the marshes and streams to spawn (Eckert, pers. comm. 1979; O'Gorman, pers. comm. 1979). Spawning runs begin before ice breakup, usually in March; ripe fish can be found in the bays for up to one month after the runs have ended in the creeks (Eckert, pers. comm. 1979). Young-of-the-year (YOY) are found in the streams and marshes; they begin moving out of the streams in June when freshets occur (Eckert and Schneider, pers. comm. 1979).

Along the northeast shore, small marshes are usually much more productive spawning areas than larger ones. Good spawning marshes in this area have a central channel with a slow flow and flooded shallow areas along shore, an average depth of not more than approximately 1.6 ft, dead and decaying vegetation on the bottom, and a supply of fathead minnows as food for the young (Marean 1976).

NO-1

Fourmile Creek (43°16', 79°00'). Spawning occurs in the lower section of the creek (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Sixmile Creek (43°17', 78°57'). Spawning occurs in the lower section of the creek (NYDEC 1977b).

Twelvemile Creek (43°19', 78°51'). The lower section of the creek is a spawning area (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

East Branch Twelvemile Creek (43°19', 78°50'). The lower 1 mi of the creek and Tuscarora Bay at the creek mouth are spawning areas (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Eighteenmile Creek (43°20', 78°43'). The lower 2 mi of the creek is a spawning area (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Keg Creek (43°21', 78°39'). Spawning occurs in the lower section of the creek (NYDEC 1977b).

Sandy Creek (43°21', 77°54'). The mouth of the creek (Straight Lake) is a productive spawning area (NYDEC 1977b).

Braddock Bay (43°19', 77°43'). A large resident population of northern pike spawns in the bay (NYDEC 1977b).

Genesee River (43°15', 77°36'). Historically, a run from the lake entered the marshes of the lower river to spawn (Greeley 1927).

Irondequoit Bay (43°14', 77°32'). A resident population exists in the bay (Eckert, pers. comm. 1979). Lake residents are also believed to enter the bay to spawn (Haines et al. 1977).

NO-2

Sodus Bay (43°15', 76°58'). A resident population exists in the bay; spawning occurs in the marshy areas of the bay (Eckert, pers. comm. 1979).

Sterling Creek (43°20', 76°41'), Ninemile Creek (43°24', 76°38'), Eightmile Creek (43°25', 76°37'), and Rice Creek (43°27', 76°34'). Resident populations spawn in these creek mouths (Bergstedt, pers. comm. 1979).

Salmon River (43°34', 76°12'). A resident population spawns in the mouth of the river (Eckert, pers. comm. 1979).

Deer Creek (43°36', 76°10'). This is a spawning area (SLEOC 1978).

North Pond (43°39', 76°11'). Northern pike spawn in the outlet area of Skinner Creek just after ice breakup (O'Gorman, pers. comm. 1979).

Lakeview Game Management Area (43°44', 76°12'). Adults enter the marsh in April to spawn; the area also supports a resident population (Panek, pers. comm. 1979).

Little Stony Creek (43°48', 76°13'). In 1974-75, adults entered the creek in April, and fry moved downstream in July and August (Marean 1976).

Ray Bay Marsh (43°50', 76°16'). In 1974-75, adults entered the marsh in late March and April, and most fry moved out in June and July (Marean 1976).

Campbell Marsh (43°55', 76°08'). The marsh is a good spawning and nursery area. Adults entered Bedford Creek (43°55', 76°07') in early April to early May, and fry moved downstream in June and July (Marean 1976; R. Werner, pers. comm. 1979).

NO-3

Muskalonge Creek (43°59', 76°02'). The creek is a good spawning area. In 1974-75, many adults entered the creek in late March to early May, and fry moved downstream in June (Marean 1976; R. Werner, pers. comm. 1979).

Perch River (44°00', 76°05'). Historically, spawning occurred in the lower river (Greene et al. 1932).

Sherwin Bay Marsh (43°59', 76°10'). In 1974-75, adults entered the marsh in April, but no fry were found. Little spawning habitat is available; the bay is larger and deeper than other areas and has a mud bottom (Marean 1976; Werner and Ford 1972).

Guffin Bay Marsh (44°02', 76°07'). This area supports spawning (Werner and Ford 1972).

Chaumont Bay (44°03', 76°12'). The bay supports a large resident population of northern pike (Eckert, pers. comm. 1979), which spawns at the mouth of the Chaumont River (44°04', 76°09') (Werner and Ford 1972). Historically, spawning occurred in the lower river (Greene et al. 1932). Isthmus Marsh (44°01', 76°17') also is good spawning habitat (Werner and Ford 1972).

Fox Creek (44°04', 76°18'). This is a good spawning and nursery area (Werner, pers. comm. 1979). Adults move into the marsh in late March and April, and fry move downstream in June (Marean, pers. comm. 1979). After the run into the creek is over, ripe fish can still be found off Fox Island (44°02', 76°20') (Eckert, pers. comm. 1979).

Mud Bay (44°05', 76°19'). Northern pike spawn in the marsh (SLEOC 1978); in 1979, YOY were very abundant in the marsh in September (Panek, pers. comm. 1979). In 1974-75, adults entered Kents Creek (44°05', 76°19') in April to early May, but no fry were found moving downstream (Marean 1976).

Wilson Bay Marsh (44°05', 76°21'). This marsh is a spawning and nursery area and is a major producer of northern pike (SLEOC 1978; Werner and Ford 1972). Many adults enter the marsh in April to early May (Dunning et al., undated; Marean 1976); runs also enter tributaries of the marsh (Eckert, pers. comm. 1979). Young-of-the-year are found throughout the weedy shallows of the bay; some of these fish move out from June to August before low water levels close the outlet to the lake. When a freshet reopens the outlet in the fall, the larger YOY move out to the lake (Eckert and Schneider, pers. comm. 1979; Marean 1976).

Ontario

OO-1

Martindale (Twelve Mile) Creek (43°10', 79°16') Historically, northern pike entered the creek to spawn; many fish were caught here in April (Kerr and Kerr 1860-1898).

Burlington Bay (43°17', 79°50'). The bay was historically an important spawning area; northern pike were present for 5-10 days in the shallows during the spawning season. In 1886, the bay and Dundas Marsh were "swarming" with pike in early April. Until about 1905, the best spawning areas were along the south shore and included Harvey's, Gages, Lottridges, Depcios, Secords, Jones, and Harris Inlets, and Big Creek Pond (exact locations unknown) (Kerr and Kerr 1860-1898; Whillans 1977). A large resident population of northern pike exists in the bay (Down, pers. comm. 1979). Dundas Marsh (43°16', 79°57') is the major spawning ground in the bay (Whillans 1977), but northern pike also enter tributaries of the bay to spawn. Spent adults were collected in the spring in Cootes Paradise at the western edge of the bay (Down, pers. comm. 1979). In 1927, YOY were collected in the bay in late August (Dymond et al. 1929).

Credit River (43°33', 79°35'). In 1866, spawning occurred in the river (Kerr and Kerr 1860-1898). In 1927, YOY were collected below the rapids and near the river mouth in June (Dymond et al. 1929).

Humber River (43°38', 79°28'). In 1866, northern pike spawned in the river (Kerr and Kerr 1860-1898).

Toronto Bay (43°38', 79°23'). Historically, large spawning runs entered the bay. In the 1860s, spawning occurred in the Don River (43°39', 79°21') (Kerr and Kerr 1860-1898; Whillans 1977). During the 1880s, northern pike also migrated by the thousands into Ashbridges Bay (43°40', 79°19') to spawn in the extensive Ashbridges Marsh at the west end of the bay (Whillans 1977). This stock declined in 1898-1919 due to the destruction of the marsh (Whillans 1979b). During the 1890s-1915, Toronto Island (43°37', 79°24') was a spawning and nursery area (Whillans

1977). Northern pike are now found only occasionally in Toronto Bay (Whillans 1977); spawning still occurs in a lagoon in the Wildlife Sanctuary on Toronto Island (Whillans, pers. comm. 1979).

OO-2

Highland Creek (43°46', 79°10'). Historically, northern pike entered the creek every spring (Kerr and Kerr 1860-1898).

Duffin Creek (43°49', 79°02'). Spawning occurred in the 1860s (Kerr and Kerr 1860-1898).

Lynde Creek (43°51', 78°57'). In the 1860s, spawning occurred here (Kerr and Kerr 1860-1898); the marshes at the creek mouth still support spawning (Environ. Can. 1977a).

Wesleyville Generating Station (43°55', 78°25'). Two marshes in the vicinity are spawning and rearing grounds (Dunford 1979).

OO-3

Prince Edward County Peninsula (44°00', 77°15'). There are several spawning sites along the south shore (Whillans, pers. comm. 1979).

Wellers Bay (44°00', 77°35'). Inside the barrier bar, between Pine (44°01', 77°36') and Smoke (44°01', 77°35') points, and around the shores near the mouth of Consecon Lake (44°00', 77°30').

Pleasant Bay (43°57', 77°30'). In the lower section of the creek feeding the bay.

Huycks Bay (43°56', 77°29'). In the lower section of Hubbs Creek.

West Lake (43°56', 77°17'). Along the inside of the barrier bar on both sides of Garratt Island (43°57', 77°18') and in the stream entering the northeast corner (43°58', 77°15').

East Lake (43°55', 77°12'). At the mouth of the stream feeding the bay (43°57', 77°10') and along shore in the southwest corner (77°14', 43°55').

South Bay (43°56', 77°02'). At the head of the embayment on the west shore (43°55', 77°03').

Smith Bay (44°00', 77°01'). At the head of the bay (43°59', 77°02'), on the north shore (44°00', 77°01'), and along the east side of Pickerel Point (43°59', 77°01').

Wolfe Island (44°10', 76°25'). Spawning occurs along the shoreline (Environ. Can. 1977a), and at a site (44°06', 76°26') in Big Sandy Bay (Whillans, pers. comm. 1979).

OO-4

Bay of Quinte (44°08', 77°15'). Northern pike spawn in the shallow marshy areas of the bay (Hurley and Christie 1977; Int. Great Lakes Levels Board 1973). The only spawning site specifically identified is the mouth of the Moira River (44°09', 77°23') (Environ. Can. 1977a). In 1928, YOY were found in mid-June in Prinyer Cove (44°05', 76°53') and in the weedy stream entering the cove (Dymond et al. 1929).

OO-5

Collins Bay (44°14', 76°37'). Spawning occurs at the head of the bay and along the eastern shore (Whillans, pers. comm. 1979).

Cataraqui Bay (44°13', 76°33'). Spawning occurs at the head of the bay at the mouth of Little Cataraqui Creek (Environ. Can. 1977a; Whillans, pers. comm. 1979).

Cataraqui River (44°14', 76°28'). Spawning occurs in the lower river along the east shore opposite Bells Island (Whillans, pers. comm. 1979).

MUSKELLUNGE

In Lake Ontario, muskellunge probably spawn in the bays and marshes of the eastern basin. Young-of-the-year are usually found around docks and boathouses (Eckert, pers. comm. 1979).

GOLDFISH

Goldfish are native to eastern Asia. It is not known when they were introduced into U.S. waters, but by 1889 a goldfish farm was operating in Maryland (Scott and Crossman 1973).

In Lake Ontario, goldfish enter marshes, bays, and harbors to spawn (Schneider and Eckert, pers. comm. 1979).

New York

NO-1

Irondequoit Bay (43°14', 77°32'). In 1977, spent fish were collected in the bay; spawning probably occurs in shallow weedy areas in May or June (Haines et al. 1977).

NO-2

Oswego (43°28', 76°31'). In 1974, eggs were entrained at the Oswego Steam Station (43°28', 76°31') in early July (Niagara Mohawk Power, undated c).

Nine Mile Point (43°31', 76°22'). In 1973, a few larvae were found here in late June (QLM 1974).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). A resident population exists in the area, and spawning occurs at Cootes Paradise (43°16', 79°55'), a shallow marsh at the western edge of the bay (Down, pers. comm. 1979). Since 1962, goldfish have spawned in Dundas Marsh (43°16', 79°57') and in almost every shallow area of Burlington Bay (Whillans 1977).

Toronto Islands (43°37', 79°23'). In 1973, goldfish were observed spawning in late May and early June in flooded lowland areas, including the Lighthouse Pond area (43°37', 79°23'), and large concentrations of newly hatched larvae were found there in early July (Wainio et al. 1973).

LAKE CHUB

Historically, lake chubs were common along shore and in coastal streams of Lake Ontario during the spawning season (Hubbs and Brown 1929). Young lake chubs were found in creeks and along the lake shore (Greeley 1940).

New York

NO-1

Sixmile Creek (43°17', 78°57'), Fish Creek (43°22', 78°32'), and Oak Orchard Creek (43°22', 78°12'). Young were found in the creeks (Greeley 1940).

Fourmile Creek (43°16', 77°26'). In 1939, several adults in breeding condition were found in the creek about 4 mi upstream in mid-April. Young were also found in the creek (Greeley 1940).

NO-2

Red Creek (43°18', 76°47') and Kay Kat Pond (43°19', 76°45'). Young were found in the pond (the mouth of Black Creek) and in Red Creek (Greeley 1940).

Ontario

OO-1

Port Credit (43°33', 79°35'). In 1927, ripe females were collected off Port Credit in June and July (Dymond et al. 1929).

Etobicoke Creek (43°35', 79°33'). In 1928, a few breeding adults were captured in the creek 1/2 mi above the mouth in late May (Hubbs and Brown 1929).

CARP

Carp were present in the New York waters of Lake Ontario prior to 1890; they originated from plantings and from accidental releases when dams on tributary streams broke (Smith 1892). Carp were probably not present in the lake before 1880 but had gained importance in the fishery by 1908 (Christie 1973).

Carp spawn in most shallow areas and bays throughout Lake Ontario (Eckert and Panek, pers. comm. 1979). Carp were also observed spawning in tributaries and in heated power plant discharges (LMS 1979a, as cited in LMS 1980). Areas that support reproduction include:

New York

NO-1

Oak Orchard Creek (43°22', 78°12'). In 1979, spawning was observed in the creek in the spring; the large size of many spawners indicated that they were lake residents (Makarewicz et al. 1979).

Genesee River (43°15', 77°36'). Historically, carp were abundant in the river below Rochester when spawning runs from the lake entered marshes at the river mouth (Greeley 1927).

Irondequoit Bay (43°14', 77°32'). In 1977, spawning and spent carp were found in the bay; spawning probably occurred in shallow, weedy areas in May or June (Haines et al. 1977).

Ginna Power Station (43°17', 77°18'). In 1977, larvae were collected nearshore from late June to early August (Bio Systems 1978a).

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1974, a few newly hatched larvae were found here, mainly in mid-July; spawning probably occurred in early July (LOTEL 1977). In 1977, larvae were collected out to the 46 ft contour from late June to mid-August; abundance peaked in early July (Rochester Gas Elec. 1977).

Oswego (43°28', 76°31'). Eggs were entrained at the Oswego Steam Station (43°28', 76°31') in early June (Niagara Mohawk Power, undated c); larvae were entrained in June to August (LMS 1976a, 1977; Niagara Mohawk Power, undated c). Newly hatched larvae were collected in the harbor turning basin from late May to mid-August and are likely the result of spawning in the basin, possibly in the lush vegetation along its south shore (Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). Eggs were collected in late June and early July (PASNY, undated b). Larvae, including newly hatched specimens, were abundant throughout the summer (LMS 1975b; PASNY, undated b; QLM 1974).

Lakeview Game Management Area (43°44', 76°12'). In 1978, spawning and spent carp were found here (Panek, pers. comm. 1979).

Ray Bay Marsh (43°50', 76°16'). In 1975-76, fry moved out of the marsh in June (Marean 1976).

Campbell Marsh (43°55', 76°08'). In 1974-75, fry moved out of the marsh in late May to mid-June (Marean 1976).

NO-3

Muskalonge Creek (43°59', 76°02'). In 1974-75, fry moved out of the marsh in early June (Marean 1976).

Sherwin Bay Marsh (43°59', 76°10'). In 1974-75, fry moved out of the marsh in mid-June to early July (Marean 1976). Historically, fry were common here in late June (Greeley and Bishop 1932).

Fox Creek Marsh (44°04', 76°18'). In 1974-75, fry moved out of the marsh in late May and early June (Marean 1976).

Ontario

In Canadian waters, carp spawning peaks in the spring, but may extend throughout most of the summer (Down, pers. comm. 1979).

OO-1

Jordan Harbour (43°11', 79°22'). A resident population spawns in the harbor in the spring; gravid females were also found in the harbor in October, but it is doubtful that any significant spawning occurred in the fall (Moccia, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). A resident population spawns in Hamilton Harbor, especially in Cootes Paradise (43°16', 79°55'), a shallow marsh at the western end of the bay (Down, pers. comm. 1979). Spawning has occurred in Hamilton Marsh (location unknown) (McCrimmon 1968); since 1908 spawning has occurred in Dundas Marsh (43°16', 79°57') and most shallow areas of Burlington Bay (Whillans 1977). In 1927, YOY were collected in a shallow vegetated area near La Salle Park (43°19', 79°49') in late July (Dymond et al. 1929).

Credit River (43°33', 79°35'). In 1927, spawning was observed in a shallow weedy backwater at the river mouth in early June at a water temperature of about 56°F. Spawning activity resumed at the end of June, after being interrupted by cool weather (Dymond et al. 1929).

Toronto Islands (43°37', 79°23'). In 1902-15, spawning occurred during the spring (Whillans, pers. comm. 1979). Carp entered Toronto Bay (43°38', 79°23') during the spawning season (Ont. Game Fish 1915). In 1973, spawning was observed in flooded lowland areas, especially around Lighthouse Pond (43°37', 79°23') in late May and early June; large concentrations of newly hatched fry were found there in early July (Wainio et al. 1973).

OO-2

Pickering Generating Station (43°48', 79°04'). Carp may be resident in the discharge area from April to November (Dunford 1976); they spawn in the discharge in late May and early June (Dunford 1979). In 1976-77, larvae were collected in small numbers along shore in the area (Dunford 1977; Dunstall 1978b).

Wesleyville Generating Station (43°55', 78°25'). Carp spawn in late May and early June in two marshes in the vicinity (Dunford 1979).

OO-4

Bay of Quinte (44°08', 77°15'). Carp spawn in the marshy areas of the bay (Hurley and Christie 1977).

GOLDEN SHINER

New York

NO-3

Black River Bay (43°59', 76°05'). A resident population spawns in Black River Bay (Eckert and Panek, pers. comm. 1979).

EMERALD SHINER

New York

NO-1

Eighteenmile Creek (43°20', 78°43'). Adults were abundant at the creek mouth during a run from the lake into the creek (Greene 1940).

Oak Orchard Creek (43°22', 78°12'). Emerald shiners spawn in the lake in this area, and juveniles enter the creek (Makarewicz 1979).

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1977, eggs were collected in late June (Rochester Gas Elec. 1977).

Oswego (43°28', 76°31'). Larvae were collected in late June and early August in the harbor turning basin (Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). In 1973, a few larvae were found here on June 20 (QLM 1974).

NO-3

Black River Bay (43°59', 76°05'). In 1972, young-of-the-year were found in the bay from mid-July to October (FWS 1978).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). In 1928, young were found along the north shore in shallow, protected water off La Salle Park (43°19', 79°49') (Dymond et al. 1929).

OO-2

Pickering Generating Station (43°48', 79°04'). In 1976, concentrations of adults were seined in the discharge area during July and August (Dunford 1976).

BRIDLE SHINER

Ontario

OO-4

Bay of Quinte (44°08', 77°15'). In 1928, breeding adults were caught at the head of Prinyer Cove (44°05', 76°53') in late May (Hubbs and Brown 1929).

COMMON SHINER

New York

NO-2

Oswego (43°28', 76°31'). Eggs were entrained at the Oswego Steam Station (43°28', 76°31') in mid-May (NMPC, undated c); larvae were entrained in early July (LMS 1976; Niagara Mohawk Power, undated c).

Nine Mile Point (43°31', 76°22'). Eggs were collected here in late May to late June (LMS 1975b, 1976b; PASNY, undated b), and a few early larvae were taken in late June and early July (LMS 1975b; QLM 1974).

Ontario

OO-1

Etobicoke Creek (43°35', 79°33'). In 1928, breeding adults were collected at the mouth of the creek in late May (Hubbs and Brown 1929).

OO-2

Highland Creek (43°46', 79°10'). In 1928, ripe adults were collected in the creek in late May (Hubbs and Brown 1929).

Duffin Creek (43°49', 79°02') and Soper Brook (43°54', 78°40'). In 1928, a few ripe females were collected in these creeks in late May (Hubbs and Brown 1929).

SPOTTAIL SHINER

In Lake Ontario, spottail shiners move inshore to spawn (LMS 1975c, as cited in LMS 1980).

New York

NO-1

Irondequoit Bay (43°14', 77°32'). Spawning occurs along the northern shoreline of the bay and the adjacent lake shoreline. In 1977, the presence of many mature, but few spent, fish indicated that spawning was not completed by mid-June (Haines et al. 1977).

NO-2

Oswego (43°28', 76°31'). In 1972, YOY were taken along shore and at the 20 ft depth contour from mid-July to October (FWS 1978). Larvae were collected in early August in the harbor turning basin (Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). In 1973, a few larvae as small as 0.2 in. long were found in late June and late August (QLM 1974).

Grindstone Creek (43°33', 76°13'). Spottail shiners spawned in the creek mouth (Greene 1940).

Henderson Bay (43°54', 76°10'). In 1972, young-of-the-year (YOY) were captured in the bay from mid-July to October (FWS 1978).

NO-3

Grenadier Island (44°03', 76°21'). In 1901, several ripe adults were found in a very large school of several thousand fish present in 3 ft of water at the head of Grenadier Island in late June (Evermann and Kendall 1902b).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). In 1927, young were found along the north shore in shallow, protected water off LaSalle Park (43°19', 79°49') (Dymond et al. 1929).

OO-4

Sandhurst (44°08', 76°52'). In 1928, breeding adults were captured on the Bay of Quinte shoreline opposite Prinyer Cove (44°05', 76°53') in late May (Hubbs and Brown 1929).

SPOTFIN SHINER

New York

NO-1

Salmon Creek (43°17', 77°11'). Historically, good spawning areas were present at the mouth of the creek (Greene 1940), but spawning at this site was not confirmed.

BLUNTNOSE MINNOW

New York

NO-1

Salmon Creek (43°17', 77°11'). Good spawning areas existed at the mouth of the creek (Greene 1940), but spawning was not confirmed at this site.

Ontario

OO-1

Etobicoke Creek (43°35', 79°33'). In 1928, breeding adults were found at the mouth of the creek in late May (Hubbs and Brown 1929).

FATHEAD MINNOW

New York

NO-2

Ray Bay Marsh (43°50', 76°16'). In 1974-75, many fry were found here in the summer, beginning in mid-June (Marean 1976; R. Werner, pers. comm. 1979).

NO-3

Fox Creek Marsh (44°04', 76°18') and Wilson Bay Marsh (44°05', 76°21'). In 1974-75, large numbers of fry were found at the mouths of these marshes in the summer, beginning in mid-June (Marean 1976; R. Werner, pers. comm. 1979).

BLACKNOSE DACE

Ontario

OO-2

Highland Creek (43°46', 79°10'), Duffin Creek (43°49', 79°02'), and Soper Brook (43°54', 78°40'). In 1928, breeding adults were found in the lower sections of these streams in late May (Hubbs and Brown 1929).

LONGNOSE DACE

Ontario

OO-1

Credit River (43°33', 79°35'). In 1927, ripe males and females were collected from the river mouth in mid-July (Dymond et al. 1929).

OO-2

Highland Creek (43°46', 79°10'). In 1928, breeding adults were collected in the creek in late May (Hubbs and Brown 1929).

OO-4

Sandhurst (44°08', 76°52'). In 1928, breeding adults were seined on the Bay of Quinte shore opposite Prinyer Cove (44°05', 76°53') in late May (Hubbs and Brown 1929).

CREEK CHUB

Ontario

OO-1

Burlington Bay (43°17', 79°50'). In 1927-28, young creek chubs were found on the north shore of Burlington Bay, in shallow water off La Salle Park (43°19', 79°49') (Dymond et al. 1929).

FALLFISH

Fallfish probably move from Lake Ontario into streams to spawn. Historically, many adults and nests were found in lower sections of tributaries (Greeley 1940), but these locations were not identified.

CYPRINID spp.

New York

NO-1

Russell Power Station (43°16', 77°38'). In 1977, larvae of carp or goldfish were collected here near shore from mid-June to late August; they were 30% of the catch of larvae made in June (Bio Systems 1978b).

SHINER spp.

New York

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1974, larvae of unidentified species of shiners were collected here during mid-June to mid-August (LOTEL 1977).

LONGNOSE SUCKER

Ontario

OO-1

Credit River (43°33', 79°35'). In 1927, young-of-the-year were collected in the river mouth in mid-July (Dymond et al. 1929).

OO-3

Smith Bay (44°00', 77°01'). In 1928, two postlarvae were found in the creek mouth and cove just west of Waupoos (44°00', 77°00') in late May (Hubbs and Brown 1929).

WHITE SUCKER

In Lake Ontario, white suckers enter many tributaries to spawn, and fry are abundant in the streams (Dymond et al. 1929; Greeley 1940; Greene 1940). Almost every tributary, at least along the eastern shore, has a spawning run during April (Bergstedt and Elrod, pers. comm. 1979; Eckert and Schneider, pers. comm. 1979).

New York

NO-1

Johnson Creek (43°22', 78°16'). The white sucker run in the creek supports a spear fishery (Buffalo Waterfront Devel. Comm., undated; Greene 1940; NYDEC 1977b).

Marsh Creek (43°22', 78°22'). The white sucker run in the creek supports a spear fishery (Buffalo Waterfront Devel. Comm., undated).

Irondequoit Bay (43°14', 77°32'). It was assumed that runs entered Irondequoit Creek (43°10', 77°32'). In 1977, large numbers of adults were not seen in the bay; however, sampling did not start until April 12, perhaps after the major part of the run had occurred (Haines et al. 1977).

NO-2

Nine Mile Point (43°31', 76°22'). White sucker larvae were found here in small numbers in late May and the first half of June (LMS 1975b; QLM 1974). Spawning probably occurred in area streams.

Grindstone Creek (43°33', 76°13') and Little Salmon River (43°31', 76°15'). White suckers were found at the stream mouths during the spawning runs (Greene 1940).

Little Stony Creek (43°48', 76°13'). In 1974-75, adults entered Black Pond and moved up into the creek in April (Marean 1976).

Ray Bay Marsh (43°50', 76°16'). In 1974-75, many adults entered the marsh in April, and a few fry were collected in late June (Marean 1976; R. Werner, pers. comm. 1979).

Bedford Creek (43°55', 76°07'). In 1974-75, many adults entered the creek in mid-April (Marean 1976).

NO-3

Sherwin Bay Marsh (43°59', 76°10'), and Muskalonge Creek (43°59', 76°02'). In 1974-75, adults entered these areas in mid-April (Marean 1976; R. Werner, pers. comm. 1979).

Wilson Bay Marsh (44°05', 76°21'), Kents Creek (44°05', 76°19'), and Fox Creek (44°04', 76°18'). In 1974-75, adults entered these areas in mid- to late April (Marean 1976).

Ontario

OO-1

Jordan Harbour (43°11', 79°22'). Spawning occurs at the back of the harbor (Moccia, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). White suckers migrate into the bay via the Burlington Canal (43°18', 79°48'), and run through Dundas Marsh (43°16', 79°57') and into Spencer (43°15', 79°57'), Dundas (43°16', 79°56'), and Grindstone (43°17', 79°53') creeks (Moccia, pers. comm. 1979; Whillans 1977, 1979b). The run occurs soon after ice breakup in late March or early April and is completed by early May (Moccia, pers. comm. 1979). Young have been found along the north shore in quiet, weedy water off La Salle Park (43°19', 79°49') (Dymond et al. 1929).

Bronte Creek (43°24', 79°43') and Credit River (43°33', 79°35'). These streams support large runs of white suckers; spawning fish have been observed (Moccia, pers. comm. 1979).

Humber River (43°38', 79°22'). A spawning run enters the river (Moccia, pers. comm. 1979).

Toronto Bay (43°38', 79°23'). Spawning occurred in this area soon after ice-out (Nash 1913). Historically, large numbers of white suckers entered bay tributaries. After 1923, runs became irregular; there are no recent records of runs in the Don River (43°39', 79°21'), the major tributary to the bay (Whillans 1977).

OO-2

Duffin Creek (43°49', 79°02'). In 1973, several hundred white suckers were found in the creek in early June (Davis et al. 1974).

Farewell Creek (43°52', 78°49'). In 1973, many white suckers were found in tributaries to the creek in early May (Davis et al. 1974; Tibbles 1978).

Graham Creek (43°54', 78°35'). In 1973, a few thousand white suckers were found in the creek in mid-May and early June (Davis et al. 1974).

Wesleyville Generating Station site (43°55', 78°25'). Two marshes in the area are spawning and rearing grounds (Dunford 1979).

OO-4

Bay of Quinte (44°08', 77°15'). In 1974, a few small larvae less than 0.5 in. long were collected in the bay from mid-May to early June. Spawning evidently occurs in bay tributaries (Lam 1977).

SILVER REDHORSE

New York

NO-1

Irondequoit Bay (43°14', 77°32'). In 1977, two spent fish were collected in Irondequoit bay; spawning was assumed to have occurred in Irondequoit Creek (43°10', 77°32') (Haines et al. 1977).

SHORTHEAD REDHORSE

Ontario

OO-1

Humber River (43°38', 79°28') and Don River (43°39', 79°21'). Runs entered these rivers in the spring (Nash 1913).

CATOSTOMID spp.

Almost all of the streams that support salmon runs, also have runs of catostomids (Bergstedt, pers. comm. 1979).

SUCKER spp.

New York

NO-2

Nine Mile Point (43°31', 76°22'). Sucker eggs were found here in benthic samples (PASNY, undated b).

Ontario

OO-1

Four Mile Creek (43°15', 79°08'), Six Mile Creek (43°15', 79°09'), Eight Mile Creek (43°14', 79°11'), Ten Mile Creek (43°13', 79°13'), Martindale (Twelve Mile) Creek (43°10', 79°16'), Fifteen Mile Creek (43°09', 79°19'), Sixteen Mile Creek (43°09', 79°20'), Jordan Harbour (Twenty Mile) Creek (43°09', 79°22'), Thirty Mile Creek (43°12', 79°28'), Forty Mile Creek (43°12', 79°33'), Fifty Mile Creek (43°14', 79°37'), Stony Creek (43°14', 79°45'), Big Creek (location unknown), Dundas Creek (43°16', 79°56'), Applegarth's Creek (location unknown), Bronte Creek (43°24', 79°43'), Oakville Creek (43°26', 79°40'), Credit River (43°33', 79°35'), tributaries at Port Nelson (location unknown), Mimico Creek (43°37', 79°29'), Humber River (43°38', 79°28'), and Don River (43°39', 79°21'). Historically, runs of suckers and "mullets" occurred in these tributaries (Kerr and Kerr 1860-1898).

OO-2

Highland Creek (43°46', 79°10'), Rouge River (43°48', 79°07'), Duffin Creek (43°49', 79°02'), and Lynde Creek (43°51', 78°57'). Historically, runs of suckers and "mullets" occurred in these tributaries (Kerr and Kerr 1860-1898).

Diamond (location unknown). Suckers entered the area in the millions from late May to early June (Ont. Game Fish 1910).

Soper Brook (43°54', 78°40'). In 1974, about 2,500 spawning suckers were found in the brook in late May (Davis et al. 1975b).

Cobourg Brook (43°57', 78°11'). In 1974, a spawning run of suckers entered the brook in late May (Davis et al. 1975b).

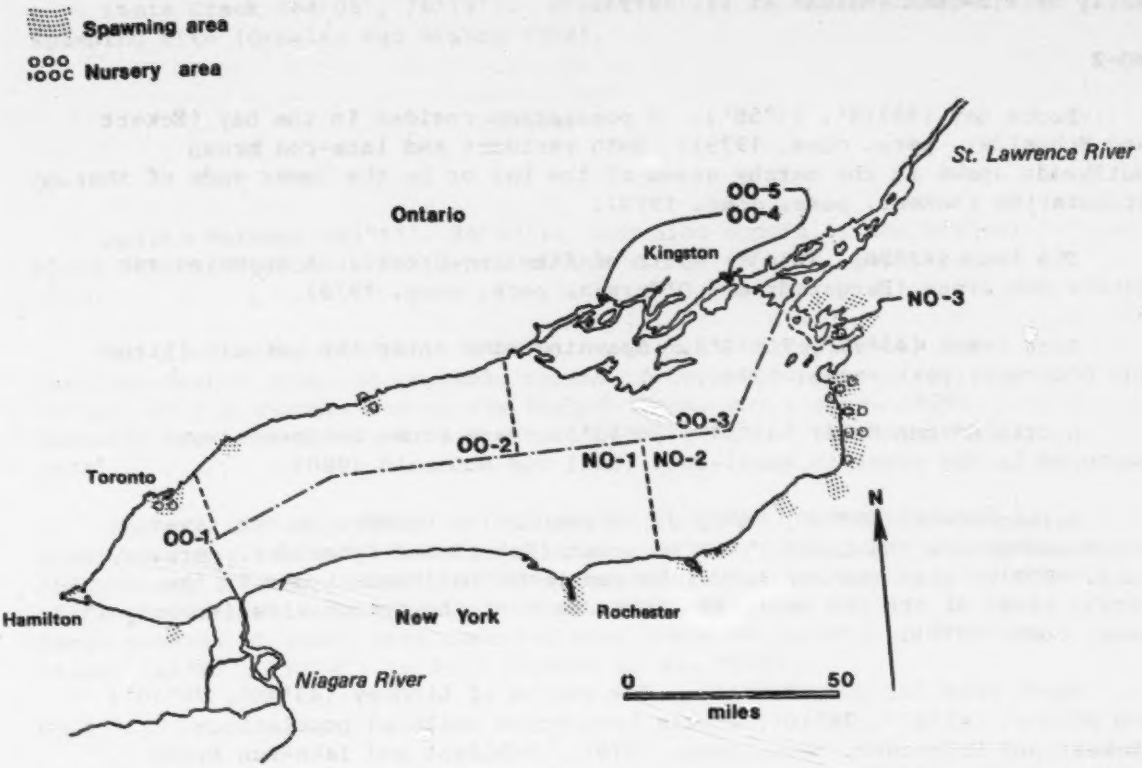
YELLOW BULLHEAD

New York

NO-2

North Pond (43°39', 76°11'). A resident population exists in (North) Sandy Pond (Eckert, pers. comm. 1979).

BROWN BULLHEAD


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Hamilton
New York
Rochester
Niagara River
0
50
miles

The brown bullhead enters marshes, bays, and creek mouths to spawn. In Lake Ontario, these spawning runs are so large that they support major sport and commercial fisheries. Almost every stream, at least along the eastern shore, that has an embayment at the mouth attracts a spawning run from April to early June, after the sucker runs. The brown bullhead builds nests in the mud or sand in shallow, weedy areas; schools of fry are found in this habitat (Eckert and Schneider, pers. comm. 1979; Greeley and Bishop 1932; Nash 1913).

NO-1

Oak Orchard Creek (43°22', 78°12'). In 1979, both mature and immature bullheads were found in the creek (Makarewicz et al. 1979); spawning runs may move into the creek from the harbor.

Irondequoit Bay (43°14', 77°32'). A population resides in the bay (Eckert and Schneider, pers. comm. 1979). Spawning occurs in the marshy areas of the bay or in the lower ends of the tributaries (Eckert pers. comm. 1979). Adults also enter the bay from the lake. In 1977, several adults were collected from nests under logs in the northwest corner of the bay. A spent female was found in early June; spawning was completed by early or mid-June (Haines et al. 1977).

NO-2

Sodus Bay (43°15', 76°58'). A population resides in the bay (Eckert and Schneider, pers. comm. 1979). Both resident and lake-run brown bullheads spawn in the marshy areas of the bay or in the lower ends of the tributaries (Eckert, pers. comm. 1979).

The Pond (43°20', 76°41'; mouth of Sterling Creek). A spawning run enters the creek (Bergstedt and O'Gorman, pers. comm. 1979).

Rice Creek (43°27', 76°34'). Spawning runs enter the estuary (Elrod and O'Gorman, pers. comm. 1979).

Little Salmon River (43°31', 76°15'). Many brown bullheads were captured in the river in April-July (Dahl and McDonald 1980).

Salmon River (43°34', 76°12'). A population resides at the river mouth and enters the lower river to spawn (Eckert and Schneider, pers. comm. 1979). Both resident and lake-run brown bullheads spawn in the marshy areas of the bay or in the lower ends of the tributaries (Eckert, pers. comm. 1979).

North Pond (43°39', 76°11'). The mouths of Lindsey (43°40', 76°10') and Skinner (43°41', 76°10') creeks have brown bullhead populations (Eckert and Schneider, pers. comm. 1979). Resident and lake-run brown bullheads spawn in the marshy areas of the bay or in the lower ends of the tributaries (Eckert, pers. comm. 1979). Historically, very large numbers of brown bullheads spawned at the mouth of North Little Sandy Pond (probably North Pond) (Smith and Snell 1891).

Lakeview Management Area (43°44', 76°12'). The marshes and creeks are important producers of brown bullheads (Werner and Ford 1972).

Black Pond (43°48', 76°14'). In 1974-75, adults entered the pond in April (Marean 1976).

NO-3

Sherwin Bay Marsh (43°59', 76°10'). In 1974-75, adults entered the marsh in mid- to late April, and a few fry were collected as they moved out of the marsh in late July (Marean 1976).

Perch River (44°00', 76°05'). Historically, the lower section of the river was a spawning area (Greene et al. 1932).

Chaumont Bay (44°03', 76°12'). Three tributaries, Three Mile (44°05', 76°12'), Shaver (44°05', 76°12'), and Soper (44°05', 76°12') creeks, may be spawning areas (Werner and Ford 1972). Historically, brown bullheads spawned in the lower section of the Chaumont River (44°04', 76°09') (Greene et al. 1932).

Kents Creek (44°05', 76°19'). Historically, this was an important spawning site (Greeley and Bishop 1932).

Ontario

OO-1

Jordan Harbour (43°11', 79°22'). Spawning occurs in the harbor; these fish are probably residents of the harbor (Moccia, pers. comm. 1979).

Burlington Bay (43°17', 79°50'). A population resides in the Hamilton Harbor area and probably spawns in Cootes Paradise (43°16', 79°55') at the western end of the harbor (Down, pers. comm. 1979). Spawning has been observed in the northwest corner of the bay (Whillans 1977).

Toronto (43°38', 79°25'). Historically, spawning was observed in Ashbridges Bay (43°40', 79°19') (Whillans 1977). Bullheads still spawn at the Toronto Islands (43°37', 79°23'); nest building was seen at the edges of flooded areas in June (Wainio et al. 1973; Whillans 1977). In 1906, large schools of young were observed near shore in lagoons on Toronto Island (43°37', 79°24') in July (Dymond et al. 1929).

OO-2

Pickering Generating Station (43°48', 79°04'). In 1976, large numbers of adults were found in the discharge area during April to July; abundance peaked in May (Dunford 1976). This may have been a spawning concentration, but very few young bullheads were found near the station. Most spawning appeared to take place in Frenchman Bay (43°49', 79°06'), which may be a nursery area (Dunford 1978d, 1979).

Wesleyville Generating Station (43°55', 78°25'). Two marshes in the area are spawning and rearing grounds (Dunford 1979).

OO-4

Bay of Quinte (44°08', 77°15'). Spawning occurs in the weed beds here (Hurley and Christie 1977).

CHANNEL CATFISH

New York

NO-3

Perch River (44°00', 76°05') and Chaumont River (44°04', 76°09'). Historically, the lower sections of these rivers were spawning areas (Greene et al. 1932).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Spawning was observed in the bay; most spawning occurred in the northwest corner of the bay (Whillans 1977).

Toronto Island (43°37', 79°24'). In the early 1870s, this was recognized as a nursery area (Whillans 1977).

TROUT-PERCH

New York

NO-2

Nine Mile Point (43°31', 76°22'). In 1974, most adults were collected in May, during the spawning period. Trout-perch larvae were found in July (LMS 1975b).

NO-3

Chaumont Bay (44°03', 76°12'). In 1972, young-of-the-year were collected in the bay from July to October (FWS 1978).

Ontario

OO-1

Credit River (43°33', 79°35'). In 1927, ripe fish were collected on the beach just outside the river mouth in late July and early August (Dymond et al. 1929).

OO-3

Pleasant Point (44°07', 76°42'). In 1928, breeding adults were found in 125 ft of water off the point in late May (Hubbs and Brown 1929).

BURBOT

Burbot spawn in nearshore areas of the lake in early April (Bio Systems 1978a).

New York

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1977, two larvae were collected in late April (Rochester Gas Elec. 1977).

Oswego (43°28', 76°31'). In 1974-76, burbot eggs were entrained by the Oswego Steam Station (43°28', 76°31') in mid-February and late April to mid-May (Niagara Mohawk Power, undated c) and were collected in the harbor turning basin in early September (Niagara Mohawk Power, undated b). In 1974-76, burbot was the earliest species of larvae collected; larvae were first found in early to mid-April (LMS 1976a; Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). In 1974-75, burbot eggs were entrained at power plants here in mid-March and early April (LMS 1975b; PASNY, undated b). Burbot is one of the most abundant larvae present (LMS 1975b); burbot larvae were collected from early April to early May (LMS 1975b; PASNY, undated a,b).

Ontario

OO-1

Port Credit (43°33', 79°35'). Spawning occurred in the Port Credit area in late January and early February (Dymond et al. 1929).

THREESPINE STICKLEBACK

In Lake Ontario, threespine sticklebacks run into creek mouths and areas further upstream to spawn (Greeley 1940; Greene 1940) and are ripe at least until late July (Dymond et al. 1929). The young are found in shallow, protected marshes and coves (Greeley 1940).

New York

NO-1

Irondequoit Bay (43°14', 77°32'). Threespine sticklebacks are present in the bay only during the spawning period. In 1977, mature adults of both sexes were first collected in early May and were common by mid-May when spawning probably began. Nesting fish were also collected in the bay (Haines et al. 1977).

NO-2

Salmon Creek (43°16', 77°02'). Good spawning habitat was present in the creek mouth (Greene 1940).

Sterling Power Plant site (43°23', 76°39'). In 1977, eggs were collected here in late June (Rochester Gas Elec. 1977).

Oswego (43°28', 76°31'). In 1975-76, adults were impinged at the Oswego Steam Station (43°28', 76°31'), usually only in April and May, when they arrived on the inshore spawning grounds (LMS 1977b; NMPC, undated c).

Nine Mile Point (43°31', 76°22'). Spawning occurs in the area. In the 1970s, large numbers of adults were impinged at power plants here in May and June; eggs and larvae were also collected (PASNY, undated a,b).

Grindstone Creek (43°33', 76°13'). Adults were present at the creek mouth, presumably for spawning (Greene 1940).

Ontario

OO-1

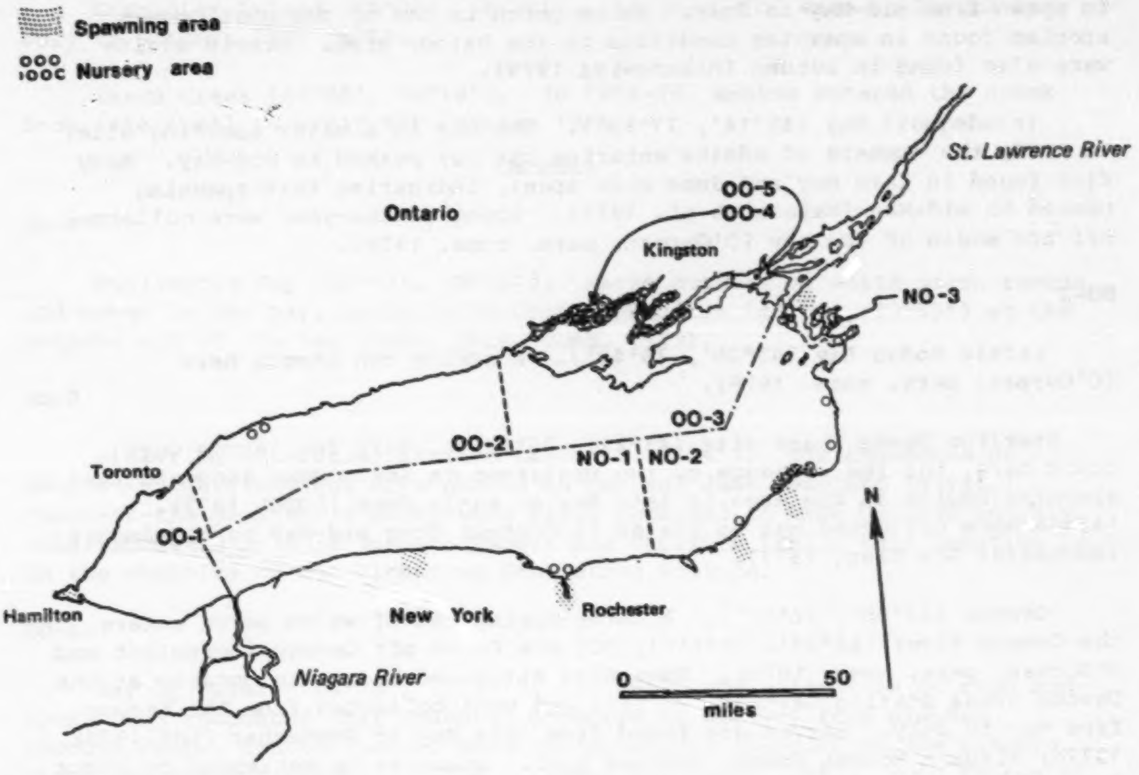
Toronto Islands (43°37', 79°23'). In 1973, spawning adults and adults in spawning condition were seen here (Wainio et al. 1973).

OO-2

Pickering (43°48', 79°04') and Darlington (43°52', 78°43') Generating Stations. Adults became abundant in June and appeared to be moving to shallow water to spawn; a few larvae were found at Darlington (Dunford 1979; Dunstall 1979b).

Wesleyville Generating Station (43°55', 78°25'). Adults became abundant in June and appeared to be moving to shallow water to spawn; no larvae were found (Dunford 1979).

WHITE PERCH


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Hamilton
New York
Rochester
Niagara River
0
50
miles

The white perch probably entered Lake Ontario in about 1950 via the Erie Barge Canal system from the Atlantic watershed. The first recorded catch was made in 1952 in the Bay of Quinte; by 1960, there was a large population in the bay (Scott and Christie 1963).

In Lake Ontario, white perch spawn from May to July at water temperatures of 52-59°F (Carter et al. 1977; Eckert and Schneider, pers. comm. 1979; Sheri and Power 1968). Spawning occurs generally throughout the lake in shallow water areas and embayments; gravid females are present in the spring along most of the lakeshore. Young-of-the-year (YOY) are found in shallow water (O'Gorman, pers. comm. 1979; Eckert and Schneider, pers. comm. 1979).

New York

NO-1

Oak Orchard Creek (43°22', 78°12'). White perch run into the creek to spawn from mid-May to July. White perch is one of the most common species found in spawning condition in the harbor area. Gravid adults were also found in autumn (Makarewicz 1979).

Irondequoit Bay (43°14', 77°32'). The bay is a major spawning site. In 1977, the numbers of adults entering the bay peaked in mid-May. Many fish found in late May and June were spent, indicating that spawning peaked in mid-May (Haines et al. 1977). Young-of-the-year were collected off the mouth of the bay (O'Gorman, pers. comm. 1979).

NO-2

Little Sodus Bay (43°20', 76°42'). A spring run occurs here (O'Gorman, pers. comm. 1979).

Sterling Power Plant site (43°23', 76°39'). Very few larvae were found here, but the presence of two prolarvae in early June suggests that spawning begins in the area in late May or early June (LOTEL 1977). Larvae were collected out to the 46 ft contour from mid-May to mid-August (Rochester Gas Elec. 1977).

Oswego (43°28', 76°31'). A large spring run of white perch enters the Oswego River (43°28', 76°31'); YOY are found off Oswego (Bergstedt and O'Gorman, pers. comm. 1979). Eggs were entrained from Lake Ontario at the Oswego Steam Station (43°28', 76°31') and were collected from the harbor from May to July. Larvae are found from late May to September (LMS 1976a, 1977b; Niagara Mohawk Power, undated b,c). Spawning is estimated to occur from mid-April to late June or July (LMS 1977b).

Nine Mile Point (43°31', 76°22'). Many adults were impinged at the Nine Mile Point Power Station (43°31', 76°25') in April, probably during the inshore spawning run. Spawning is believed to occur from early June to mid-July at water temperatures of 50-72°F. Larvae, 0.1-0.2 in. long, are abundant in the area from June to August, and YOY up to 2.3 in. long are present in large numbers in August (QLM 1974); YOY are found in shallow water from August to October (Bergstedt 1978; O'Gorman, pers. comm. 1979). In 1974-76, eggs were collected from April to September (LMS 1975b, 1976b; PASNY, undated b).

North Pond (43°39', 76°11'). In 1972, YOY were found in the lake off the mouth of the pond in October (O'Gorman, pers. comm. 1979).

Southwick Beach State Park (43°46', 76°13'). In 1972, YOY were found here (O'Gorman, pers. comm. 1979).

NO-3

Guffin Bay (44°02', 76°07') and Black River Bay (43°59', 76°05'). In 1972, YOY were found in these bays (O'Gorman, pers. comm. 1979).

Chaumont Bay (44°03', 76°12'). In 1972, YOY were collected in the bay and at the mouth of the bay from July to October (FWS 1978; O'Gorman, pers. comm. 1979).

Grenadier Island (44°03', 76°21'). In 1972, YOY were collected from July to October (FWS 1978).

Kents Creek (44°05', 76°19'). In 1974-75, adults entered the creek from late April to early May (Marean 1976).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Large numbers of white perch reside and spawn in the bay, probably in Cootes Paradise (43°16', 79°55') at the western end of the bay (Down, pers. comm. 1979).

OO-2

Pickering Generating Station (43°48', 79°04'). The abundance of adults in the discharge area peaked in May and June (Dunford 1976a). Young-of-the-year white perch were first recorded in Lake Ontario in July, 1953, about 12 mi E of Toronto (Scott and Christie 1963); this location is in the vicinity of the Pickering Generating Station.

OO-4

Bay of Quinte (44°08', 77°15'). In 1967, the collection of ripe and spent fish indicated that spawning occurred in the bay from mid-May through June. Gravid females were collected off the dock of the Glenora Fisheries Station (44°02', 77°04') (Sheri and Power 1968). Both shores of Adolphus Reach from Keith Shoal (44°02', 77°00') to Upper Gap (44°07', 76°49') are important spawning areas (Environ. Can. 1977a). In 1974, white perch larvae and YOY were collected throughout the bay from mid-May to mid-September. Larvae were most abundant in the upper bay and especially in upper Hay Bay (44°10', 76°56'); this suggested that the white perch ran into the warmer waters in the upper bay to spawn. Eggs were found in the bay, often adhering to Myriophyllum (Lam 1977). White perch also spawn in the discharge canal of the Lennox Generating Station (44°09', 76°51'); eggs were found among Cladophora on the bottom of the canal. Ripe adults moved inshore in early June and spawned in June and July at water temperatures of 59-73°F (Dunford 1978a; Griffiths 1976b). Larvae first appeared in the vicinity of the station in early June and were most abundant in the discharge canal; the canal may be an important spawning area (Dunford 1978a). Larvae were present in surface waters for about 6 weeks and were found at sampling sites east and west of the Lennox Generating Station and at Pig Point (44°08', 76°49') and Indian Point (44°07', 76°51'). The highest densities of newly hatched larvae, as small as about 0.1 in. long, were at Indian Point. Fry were generally associated with heavy growths of Myriophyllum. Young-of-the-year were collected near the station from July to September (Griffiths 1976b). Adults disappeared from catches in about mid-July and may have moved westward into the Bay of Quinte (Dunford 1976b).

WHITE BASS

New York

NO-2

Oswego (43°28', 76°31'). Larvae were collected in June and July in Oswego Harbor (Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). In 1973, some early larvae about 0.1-0.2 in. long were collected here during the first half of June (QLM 1974). Larvae were entrained at the Fitzpatrick Power Plant (43°31', 76°24') in May (PASNY, undated b).

Ontario

OO-1

Toronto (43°38', 79°25'). Gravid females were collected from the bay just off the outfall of the Hearn Generating Station (43°39', 79°20') (Whillans, pers. comm. 1979).

OO-2

Lynde Creek (43°51', 78°57'). Spawning occurs at the creek mouth (Balesic 1979c; Environ. Can. 1977a).

Second Marsh [location uncertain; west of McLaughlin Bay (43°52', 78°48')] and Bowmanville Creek (43°54', 78°40'). Spawning occurs in these areas (Balesic 1979c).

ROCK BASS

Rock bass move inshore to spawn over gravel in 3-20 ft of water. Migration begins at a water temperature of 55°F; spawning occurs in June and July and begins at a water temperature of about 60°F (Schneider, pers. comm. 1979).

New York

NO-1

Oak Orchard Creek (43°22', 78°12'). The rock bass is not a year-round resident of the creek but is one of the most common species found in spawning condition in the harbor area. Spawning was observed along shore in the lower creek. The shallow, vegetated sites are important nursery areas (Makarewicz et al. 1979).

Irondequoit Bay (43°14', 77°32'). A large spring run occurred (Odell 1940).

NO-2

Sodus Bay (43°15', 76°58'). The spawning run into the bay did not reach the head of the bay or proceed east of the islands in the bay every year (Odell 1940).

Blind Sodus Bay (43°20', 76°44'). This is a spawning area (NYDEC 1977b).

Little Salmon River (43°31', 76°15'). Spawning occurred at the river mouth (Greene 1940).

NO-3

Chaumont Bay (44°03', 76°12'). This is a spawning and nursery area (Schneider, pers. comm. 1979). Unspent females and many males guarding nests were found on the rocky shoals of the bay in mid-June at a water temperature of 67°F (Greeley and Bishop 1932).

Wilson Bay (44°05', 76°21'). Spawning occurs over gravel in the corners of the bay (Schneider, pers. comm. 1979).

Fuller Bay (44°06', 76°22'). Spawning occurs over gravel areas (Schneider, pers. comm. 1979).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Young rock bass were found in shallow, vegetated water along the north shore of the bay off La Salle Park (43°19', 79°49') (Dymond et al. 1929).

OO-2

Pickering Generating Station (43°48', 79°04'). Rock bass are significantly more abundant here from April to July (Dunford 1976), but very few larvae have been collected (Dunford 1977).

PUMPKINSEED

In Lake Ontario, the shallow areas and embayments, especially in the eastern basin, are spawning and nursery areas (Eckert, pers. comm. 1979).

New York

NO-1

Oak Orchard Creek (43°22', 78°12'). The lower creek is a major spawning and nursery area. The pumpkinseed is one of the most common fishes found in spawning condition in the harbor. Many adults guarding nests were found in the creek (Makarewicz 1979).

Irondequoit Bay (43°14', 77°32'). In 1977, nesting fish were observed here, most commonly in the northwest corner of the bay. Some fish deserted nests during cold weather in late May and then returned to the nests in June (Haines et al. 1977).

NO-2

Black Pond (43°48', 76°14'). In 1974-75, several adults moved into the pond and into Little Stony Creek (43°48', 76°13') in April, but no fry were found in the area (Marean 1976).

Ray Bay Marsh (43°50', 76°16'). In 1974-75, several adults entered the marsh in mid-April, and several fry were found there in late July (Marean 1976).

Henderson Bay (43°54', 76°10'). A very large resident population spawns in the littoral zone of the bay (Schneider, pers. comm. 1979).

Campbell Marsh (43°55', 76°08'). In 1974-75, several adults entered the marsh in April and a few fry were found there in July (Marean 1976).

NO-3

Muskalonge Creek (43°59', 76°02'). In 1974-75, several adults entered the marsh in the lower creek in April, and a few fry were found there in July (Marean 1976).

Sherwin Bay Marsh (43°59', 76°10'). In 1974-75, adults entered the marsh in late April; a few fry were found in the marsh in mid- to late July (Marean 1976).

Chaumont Bay (44°03', 76°12'). A very large resident population spawns in the littoral zone of the bay (Schneider, pers. comm. 1979).

Fox Creek (44°04', 76°18'). In 1974-75, adults entered the marsh from late April to early May, but no fry were found there (Marean 1976).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Pumpkinseeds have always spawned in the bay (Whillans 1977). In 1927-28, young were found along the north shore in shallow protected water off La Salle Park (43°19', 79°49') (Dymond et al. 1929).

Toronto Bay (43°38', 79°23'). Spawning was observed in the bay and at Toronto Islands (43°37', 79°23'); nest building was seen at the margins of flooded areas in June (Wainio et al. 1973; Whillans 1977).

OO-2

Wesleyville Generating Station (43°55', 78°25'). Two marshes in the area are spawning and rearing grounds (Dunford 1979).

OO-4

Bay of Quinte (44°08', 77°15'). A few young-of-the-year were found in the vicinity of the Lennox Generating Station (44°09', 76°51') in August and September (Dunford 1978a).

BLUEGILL

In Lake Ontario, the shallow areas and embayments, especially in the eastern basin are spawning and nursery areas (Eckert, pers. comm. 1979).

New York

NO-1

Oak Orchard Creek (43°22', 78°12'). The creek is a major spawning and nursery area (Makarewicz et al. 1979).

NO-2

Ray Bay Marsh (43°50', 76°16'). In 1974-75, fry were found here (Marean 1976).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). In 1927-28, young were found in a protected inlet at the western end of the bay (Dymond et al. 1929).

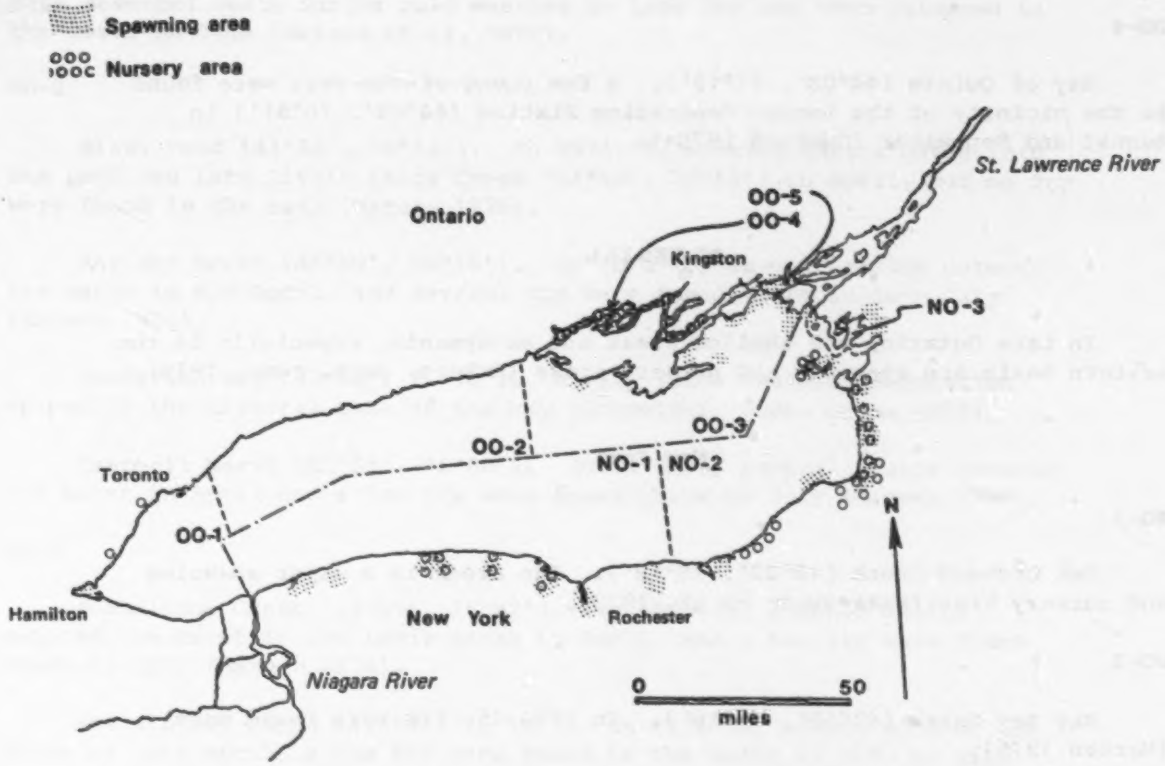
SUNFISH spp.

Ontario

OO-4

Bay of Quinte (44°08', 77°15'). In 1974, sunfish larvae were collected in the bay from June to September (Lam 1977).

SMALLMOUTH BASS


▨ Spawning area
○○○ Nursery area
Ontario
St. Lawrence River
OO-5
OO-4
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
OO-1
N
Hamilton
New York
Rochester
Niagara River
0
50
miles

In Lake Ontario, smallmouth bass move inshore at a water temperature of about 55°F and spawn over gravel in 3-15 ft of water at a temperature of about 60°F. Spawning runs also enter tributaries in some areas of the lake; these streams are important spawning and nursery areas. The young move out of the tributaries during the summer and fall (Eckert and Schneider, pers. comm. 1979; Greeley, undated). Spawning runs do not usually enter streams at the eastern end of the lake north of Stony Point, because the streams in that area lack suitable substrate. Along the south shore, most spawning occurs in the lower sections of streams (Eckert and Schneider, pers. comm. 1979). Much of the rocky shoreline from Sodus Bay to Salmon River is an important spawning area for smallmouth bass (O'Gorman, pers. comm. 1979). Several distinct smallmouth bass populations exist in Lake Ontario, each of which spawns in a localized geographic area (Eckert, pers. comm. 1979). The exact time of spawning is dependent on water temperature. Spawning in tributaries and embayments may occur from late May to early June; in the lake proper, spawning may be delayed until late June or July (Greeley, undated; Stone et al. 1951, 1954). Early records report that smallmouth bass were still full of spawn in July (Kerr and Kerr 1860-1898); in some years spawning did not occur before July 15 (Ont. Game Fish 1910; Taudvim 1910).

New York

NO-1

Twelvemile Creek (43°19', 78°51'). The lower creek is a spawning area (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

East Branch Twelvemile Creek (43°19', 78°50'). Tuscarora Bay at the mouth of the creek and the lower 1 mi of the creek are spawning areas (Buffalo Waterfront Devel. Comm., undated; NYDEC 1977b).

Eighteenmile Creek (43°20', 78°43'). The lower 2 mi section of the creek is a spawning area (NYDEC 1977b).

Johnson Creek (43°22', 78°16'). Historically, this creek was an excellent spawning and nursery area; nests and fry were seen here (Greeley 1940; Greene 1940).

Oak Orchard Creek (43°22', 78°12'). This creek is an excellent spawning and nursery area; spent adults and young were found here (Makarewicz et al. 1979; NYDEC 1977b).

Sandy Creek (43°21', 77°54'). This is an excellent spawning stream; the mouth area (Straight Lake) is especially productive (NYDEC 1977b).

Black (Northrup) Creek (43°17', 77°43'). This creek is a spawning and nursery area (NYDEC 1977b).

Irondequoit Bay (43°14', 77°32'). This has long been a spawning area (NYDEC 1977b).

Salmon Creek (43°17', 77°11'). Spawning occurs at the creek mouth (NYDEC 1977b).

NO-2

Port Bay (43°18', 76°50'). This is a spawning area (NYDEC 1977b). Wolcott Creek (43°16', 76°50') has favorable substrate and is a potential spawning area (Eckert and Schneider, pers. comm. 1979).

Blind Sodus Bay (43°20', 76°44'). This is a spawning area (NYDEC 1977b).

Sterling Creek (43°20', 76°41'), Sterling Valley Creek (43°21', 76°40'), Ninemile Creek (43°24', 76°38'), and Eightmile Creek (43°25', 76°37'). Fry were observed in the lower reaches of these creeks (Eckert and Schneider, pers. comm. 1979).

Nine Mile Point (43°31', 76°22'). Peak spawning occurred here in late June and July. Very few males were collected, possibly because they were on nests (QLM 1974). No eggs and only one larva were found, but the presence of adults suggested that spawning occurred in the area (PASNY, undated a).

Butterfly Creek (43°31', 76°18'). Fry were found in the lower section of the creek (Eckert and Schneider, pers. comm. 1979).

Little Salmon River (43°31', 76°15'). A spawning run enters the lower section of the creek; fry and nests were observed there (Eckert and Schneider, pers. comm. 1979; Greeley 1940; Greene 1940).

Sage Creek (43°32', 76°14'). A spawning run enters the lower section of the creek (Eckert and Schneider, pers. comm. 1979).

Grindstone Creek (43°33', 76°13'). A spawning run enters the lower section of the creek; fry and nests were observed (Eckert and Schneider, pers. comm. 1979; Greeley 1940; Greene 1940).

Salmon River (43°34', 76°12'). In the late 1930's, a heavy spawning run entered the river, and fry were abundant there; however, spawning was believed to have been adversely affected by fluctuating water levels caused by dams and by lack of spawning sites (Greene 1940). Nests and fry were seen in shallow coves in June and in deeper water in July (Greeley 1940).

Lindsey Creek (43°40', 76°10') and Skinner Creek (43°41', 76°10'). Smallmouth bass enter these creeks; the lower sections are spawning and nursery areas (Eckert and Schneider, pers. comm. 1979).

Lakeview Game Management Area (43°44', 76°12'). This area, which includes Sandy (43°44', 76°12') and South Sandy (43°43', 76°12') creeks, is an important producer of smallmouth bass (Werner and Ford 1972). The creeks support spawning runs (SLEOC 1978); a major run enters South Sandy Creek (Eckert and Schneider, pers. comm. 1979). The lower sections of the creeks are spawning and nursery areas (Eckert and Schneider, pers. comm. 1979).

Stony Creek (43°50', 76°14'). Many smallmouth bass enter the creek; the lower section is a spawning and nursery area (Eckert and Schneider, pers. comm. 1979). Spawning occurred earlier here than farther out in the lake (Stone et al. 1951, 1954). Smallmouth bass fry were abundant in the creek 2 mi above the mouth in late June (Greeley and Bishop 1932).

Stony Island (43°54', 76°20'). A discrete spawning population exists in the area (SLEOC 1978; Stone et al. 1954).

Galloo Island (43°54', 76°25'). A discrete population exists in the area (SLEOC 1978; Stone et al. 1954). Spawning occurs later here than in tributaries; spawning and unspent adults were found in late July. Young-of-the-year (YOY) were abundant on the "gas buoy" shoals (location unknown), off Galloo Island, in late July (Greeley, undated).

NO-3

Perch River (44°00', 76°05'). Historically, smallmouth bass spawned in the lower section of the river (Greene et al. 1932).

Chaumont Bay (44°03', 76°12'). A discrete population moves into the bay from the open lake at spawning time (SLEOC 1978; Stone et al. 1951, 1954). The western part of the bay is a spawning and nursery area (Eckert and Schneider, pers. comm. 1979). Historically, spawning occurred in the lower Chaumont River (44°04', 76°09') (Greene et al. 1932).

Wilson Bay (44°05', 76°21'). A discrete population exists in the area (SLEOC 1978; Stone et al. 1951, 1954); spawning occurs in gravel areas in the corners of the bay (Eckert and Schneider, pers. comm. 1979). Smallmouth bass move into the bay from the lake to spawn (Webster et al. 1959).

Fuller Bay (44°06', 76°22'). A discrete smallmouth bass population spawns in Fuller Bay (Eckert, pers. comm. 1979) over gravel (Eckert and Schneider, pers. comm. 1979).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Historically, the south shore, including Harvey's, Lottridges, Gages, Depcios, Secords, Jones, and Harris inlets, and Big Creek Pond (specific locations unknown) were major spawning areas. Since 1876, spawning has occurred in Dundas Marsh (43°16', 79°57') (Kerr and Kerr 1860-1898; Whillans 1977).

Bronte (Twelve Mile) Creek (43°24', 79°43'). In 1927-28, YOY were found in Bronte Creek in late July and mid-August (Dymond et al. 1929).

Credit River (43°33', 79°35'). In 1927-28, YOY were found in a backwater in late July and mid-August (Dymond et al. 1929).

OO-3

Prince Edward County Peninsula (44°00', 77°15'). Spawning occurs in the following areas:

Wellers Bay (44°00', 77°35'), Sugar Point (44°00', 77°34'), Smoke Point (44°01', 77°35'), and the first point inside the barrier bar (43°59', 77°34') (Whillans, pers. comm. 1979).

Huycks Point (43°56', 77°29') (Environ. Can. 1977a).

West Lake (43°56', 77°17'). Around the point on Poplar Island (43°57', 77°18'). False Ducks Island (43°57', 76°48'), and Timber Island (43°57', 76°50') (Whillans, pers. comm. 1979).

Flatt Point (43°56', 77°00'). East shore. Waupoos Island (44°00', 76°58'). North end and along the mainland shore opposite the island (44°00', 76°59'). Green Island (44°01', 76°56') and Cressy Point (44°04', 76°53'). Along the south shore (Whillans, pers. comm. 1979).

Amherst Island (44°09', 76°43'). Spawning occurs at Gull Point (44°06', 76°46'), along the entire shoreline between Wemps Bay (44°07', 76°47') and Amherst Bay (44°06', 76°44'), at Nut Island (44°06', 76°43'), and at Emeric Point (44°06', 76°42') (Whillans, pers. comm. 1979).

Simcoe Island (44°10', 76°32'). Central south shore (Environ. Can. 1977a; Whillans, pers. comm. 1979).

Wolfe Island (44°10', 76°25'). The shoreline areas around the island provide much spawning habitat (Environ. Can. 1977a,b).

Hinckley Point (44°08', 76°22') to Bear Point (44°06', 76°26') (Environ. Can. 1977b).

Big Sandy Bay (44°06', 76°28') (Eckert and Schneider, pers. comm. 1979; Whillans, pers. comm. 1979).

Long Point (44°06', 76°29') (Environ. Can. 1977b; Whillans, pers. comm. 1979).

Reeds Bay (44°08', 76°29') (Eckert and Schneider, pers. comm. 1979; Environ. Can 1977b; Whillans, pers. comm. 1979).

Bells Point (44°08', 76°30'). East of the point along shore to Reeds Bay (Environ. Can. 1977b).

Sand Bay (44°09', 76°31') (Environ. Can. 1977a; Whillans, pers. comm. 1979).

Mill Point (44°11', 76°28'). From the point west to the boat channel (Environ. Can. 1977b).

Barrett Bay (44°12', 76°27') (Environ. Can. 1977b).

Pigeon Island (44°04', 76°33') (Whillans, pers. comm. 1979).

Charity Islands (44°02', 76°30'). The gravel shoals have long been known as a spawning area (Eckert and Schneider, pers. comm. 1979; SLEOC 1978; Stone et al. 1951, 1954; Whillans, pers. comm. 1979).

OO-4

Bay of Quinte (44°08', 77°15'). Smallmouth bass spawn on the gravel shoals in the bay (Hurley and Christie 1977). Spawn was collected from ripe fish in the bay (Rodd 1913). In 1974, a few larvae were collected in mid-May (Lam 1977).

Kerr Point (44°10', 76°43') (Environ. Can. 1977a).

OO-5

Amherst Bar (44°12', 76°37')--Brother Islands (44°12', 76°38') (Whillans, pers comm. 1979).

Collins Bay (44°14', 76°37'). Spawning occurs along the east shore at the bay mouth. Salmon Island (44°12', 76°35') and Snake Island (44°11', 76°33') (Whillans, pers. comm. 1979).

Melville Shoal (44°11', 76°35') (Environ. Can. 1977a).

Everett Point (44°13', 76°35') (Whillans, pers. comm. 1979).

Little Cataraqui Creek (44°13', 76°33'). Spawning occurs at the creek mouth (Environ. Can. 1977a).

Simcoe Island (44°10', 76°32'). North shore around Four Mile Point (44°11', 76°31') (Environ. Can. 1977a; Whillans, pers. comm. 1979).

Garden Island (44°12', 76°28'). Spawning occurs along the north shore (Environ. Can. 1977a; Whillans, pers. comm. 1979).

LARGEMOUTH BASS

In Lake Ontario, largemouth bass are common residents of the shallow, marshy areas, including most creek mouths and embayments; they also reproduce in these areas (Schneider, pers. comm. 1979).

New York

NO-1

Oak Orchard Harbor (43°22', 78°12'). In 1979, two gravid adults were found here in the spring (Makarewicz et al. 1979).

Braddock Bay (43°19', 77°43'). A large resident population reproduces in the bay (NYDEC 1977b).

Irondequoit Bay (43°14', 77°32'). In 1977, nesting fish were found in early June after a cold spell had forced them to desert nests in late May (Haines et al. 1977).

NO-2

Sterling Creek (43°20', 76°41'). Fry were observed here (Schneider, pers. comm. 1979).

Lakeview Game Management Area (43°44', 76°12'). This area, including Sandy (43°44', 76°12') and South Sandy (43°43', 76°12') creeks, is an important producer of largemouth bass (Werner and Ford 1972). A population resides in the area and spawns at the confluence of the creeks (Schneider, pers. comm. 1979).

Black Pond (43°48', 76°14'). In 1974-75, a few adults entered the pond and Little Stony Creek (43°48', 76°13') in April, and several fry were found in the pond and the creek in late June and July (Marean 1976), indicating that the site is a nursery area (R. Werner, pers. comm. 1979).

NO-3

Black River Bay (43°59', 76°05'). In 1972, YOY were captured in the bay from mid-July to October (FWS 1978). Historically, spawning occurred in the lower reaches of the Perch River (44°00', 76°05') (Greene et al. 1932).

Chaumont River (44°04', 76°09'). Spawning occurred in the lower river (Greene et al. 1932).

Kents Creek (44°05', 76°19'). A few fry were found in the creek in late July; young-of-the-year (YOY) are found in Mud Bay at the mouth of the creek in the fall (Marean 1976; Panek, pers. comm. 1979).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Since 1876, spawning has occurred in Dundas Marsh (43°16', 79°57') (Whillans 1977). In 1928, young were found along the north shore of the bay in shallow protected water off La Salle Park (43°19', 79°49') (Dymond et al. 1929).

Toronto (43°38', 79°25'). Young-of-the-year were abundant in Ashbridges Bay (43°40', 79°19') and also in the shallows of Toronto Bay (43°38', 79°23') (Dymond et al. 1929).

OO-3

Prince Edward County Peninsula (44°00', 77°15'). Spawning occurs in several areas in water slightly deeper than that in which northern pike spawn (Whillans, pers. comm. 1979).

> Wellers Bay (44°00', 77°35'). Inside the barrier bar (43°59', 77°35'), and at the lower end of Consecon Lake (44°00', 77°30').
>
> West Lake (43°56', 77°17'). Inside the barrier bar on both sides of Garratt Island (43°57', 77°18') and at the mouth of the stream entering the northeast side (43°58', 77°15').
>
> East Lake (43°55', 77°12'). At the head of the bay (43°57', 77°10') and in the southwest (43°54', 77°14') and southeast (43°54', 77°12') corners.

Black River (43°58', 77°02'). At the river mouth.

Smith Bay (44°00', 77°01'). At the head of the bay (43°59', 77°02').

OO-4

Bay of Quinte (44°08', 77°15'). Largemouth bass spawn in the weedy areas of the bay (Hurley and Christie 1977). A few larvae were found in the marshy area at the head of Prinyer Cove (44°05', 76°53') in late May (Hubbs and Brown 1929).

OO-5

Collins Bay (44°14', 76°37'). Head of the bay (Whillans, pers. comm. 1979).

Cataraqui Bay and mouth of Little Cataraqui Creek (44°13', 76°33'). (Environ. Can. 1977a; Whillans, pers. comm. 1979).

Cataraqui River (44°14', 76°28'). East shore of the lower river (Whillans, pers. comm. 1979).

Garden Island (44°12', 76°28'). South shore (Whillans, pers. comm. 1979).

BASS spp.

New York

NO-2

Pleasant Point (43°31', 76°20'). An unidentified species of bass spawned on the gravel shoals just off the point (Smith and Snell 1891).

Ontario

OO-1

Martindale (Twelve Mile) Creek (43°10', 79°16'). Many bass were seined here in early April (Kerr and Kerr 1860-1898).

Bronte (43°24', 79°43'). Tributaries at Bronte were spawning areas (Kerr and Kerr 1860-1898). Bronte Creek (43°24', 79°43') was a well known spawning site for black bass; some fish migrated 10 mi upstream to spawn (Ont. Game Fish 1911).

Oakville (43°26', 79°40'). Tributaries at Oakville were spawning areas (Kerr and Kerr 1860-1898).

Credit River (43°33', 79°35'). Spawning occurred here in 1866 (Kerr and Kerr 1860-1898).

Mimico (43°37', 79°29') and Port Nelson (location unknown). Tributaries here were spawning areas (Kerr and Kerr 1860-1898).

Humber River (43°38', 79°28') and Don River (43°39', 79°21'). In 1866, bass spawned in these rivers (Kerr and Kerr 1860-1898).

OO-2

Rouge River (43°48', 79°07'), Duffin Creek (43°49', 79°02'), and Lynde Creek (43°51', 78°57'). In 1866, bass spawned in these tributaries (Kerr and Kerr 1860-1898).

Diamond (location unknown). This area was a good breeding ground for bass (Ont. Game Fish 1910).

WHITE CRAPPIE

Ontario

OO-1

Burlington Bay (43°17', 79°50'). In 1927-28, young-of-the-year were found in a protected inlet of a sluggish creek entering the northwest corner of the bay (Dymond et al. 1929).

BLACK CRAPPIE

New York

NO-1

Irondequoit Bay (43°14', 77°32'). In 1977, young-of-the-year (YOY) were found in the bay, but spawning was not confirmed (Haines et al. 1977).

NO-2

Black Pond (43°48', 76°14'). In 1974-75, adults entered the pond in mid-April (Marean 1976).

NO-3

Muskalonge Creek (43°59', 76°02'). In 1974-75, a few adults entered the creek in late March to April (Marean 1976).

Perch River (44°00', 76°05'). Spawning occurred in the lower section of the river (Greene et al. 1932).

Sherwin Bay Marsh (43°59', 76°10'). In 1974-75, adults entered the marsh in late April (Marean 1976).

Chaumont River (44°04', 76°09'). Spawning occurred in the lower section of the river (Greene et al. 1932).

Fox Creek (44°04', 76°18'). In 1974-75, adults entered the creek in mid- to late April (Marean 1976).

Kents Creek (44°05', 76°19'). In 1974-75, adults entered the creek in mid- to late April (Marean 1976); YOY were also found in the creek (Eckert, pers. comm. 1979).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). In 1877, ripe adults were found in Dundas Marsh (43°16', 79°57') in late May (Dymond et al. 1929).

Credit River (43°33', 79°35'). In 1928, a ripe female was found among aquatic vegetation in the river (Dymond et al. 1929).

Toronto Island (43°37', 79°24'). In about 1895, spawning occurred at Toronto Island; since 1913, black crappies have not been abundant here (Whillans 1977).

CRAPPIE spp.

New York

NO-2

Blind Sodus Bay (43°20', 76°44'). This is a spawning area for unidentified species of crappie (NYDEC 1977b).

JOHNNY DARTER

Historically, ripe adults were collected in Lake Ontario in late June (Dymond et. al. 1929).

New York

NO-1

Russell Power Station (43°16', 77°38'). In 1977, johnny darter larvae were collected from mid-June to August; they were most abundant on July 14, when they made up 85% of the catch of benthic larvae (Bio Systems 1978b).

Irondequoit Bay (43°14', 77°32'). In 1977, nesting fish were found in the northwest corner of the bay during May (Haines et al. 1977).

Ginna Power Station (43°17', 77°18'). Johnny darters spawn in the nearshore areas here. In 1977, larvae were collected out to the 36 ft depth contour in late June to August; they were most abundant in mid-July and were 75% of the larval catch at this time (Bio Systems 1978a).

NO-2

Blind Sodus Bay (43°20', 76°44'). Ripe adults in breeding colors were collected over rock in 30 ft of water off the bay in late June (Bergstedt, pers. comm. 1979).

Sterling Power Plant site (43°23', 76°39'). In 1977, larvae were collected from May 10 to late June (LOTEL 1977).

Oswego (43°28', 76°31'). Larvae were entrained from Lake Ontario at the Oswego Steam Station (43°28', 76°31') in June and July (LMS 1976a, 1977b; Niagara Mohawk Power, undated c); larvae were collected in the lake from June to September (LMS 1976a, 1977b) and in the harbor turning basin from late May to August (Niagara Mohawk Power, undated b). In 1974, 83% of the benthic larvae collected on July 8 were johnny darters (LMS 1976a).

Nine Mile Point (43°31', 76°22'). Eggs were found here in early June (PASNY, undated b). In 1973-76, johnny darter larvae were one of the most abundant larvae in the area; they were present near shore and off shore from May to September (LMS 1975b, 1976b; PASNY, undated a,b; QLM 1974).

NO-3

Chaumont Bay (44°03', 76°12'). In 1972, young-of-the-year were found in the bay from mid-July to October (FWS 1978).

Ontario

OO-1

Toronto Islands (43°37', 79°23'). In 1973, spawning adults and adults in spawning condition were found in the area (Wainio et al. 1973).

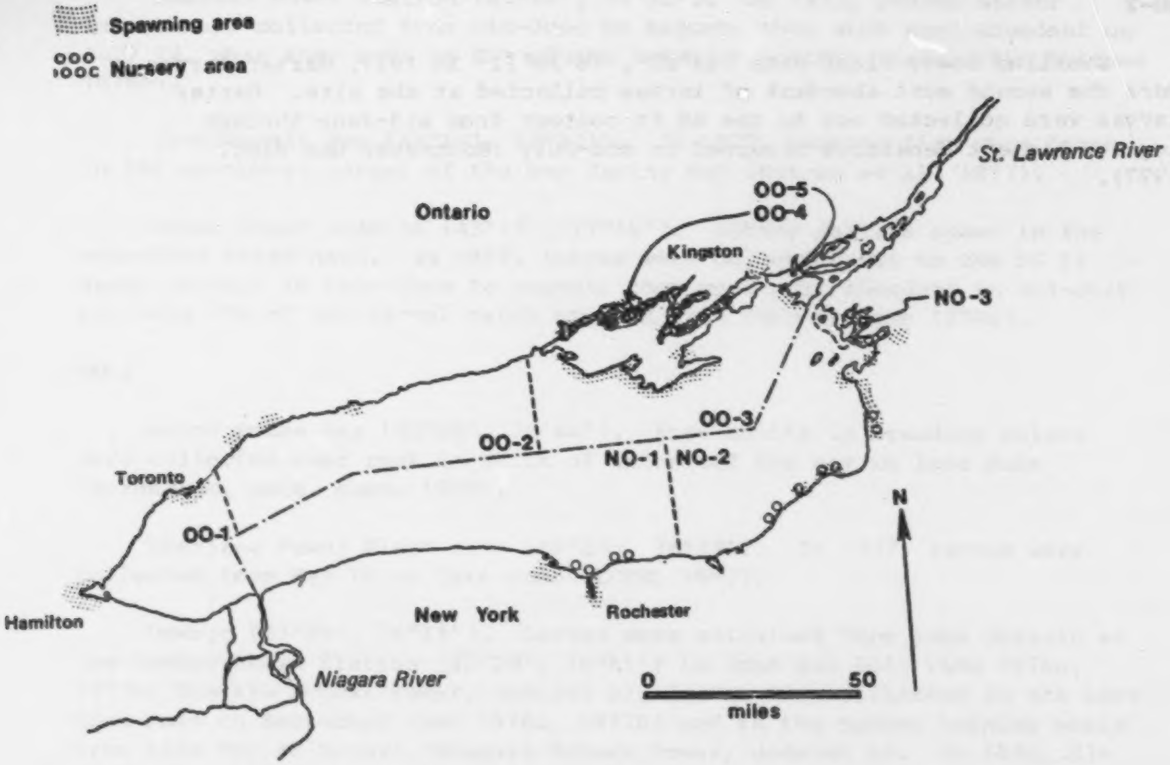
DARTER spp.

New York

NO-2

Sterling Power Plant Site (43°23', 76°39'). In 1977, darter larvae were the second most abundant of larvae collected at the site. Darter larvae were collected out to the 46 ft contour from mid-June through August; highest densities occurred in mid-July (Rochester Gas Elec. 1977).

YELLOW PERCH


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Hamilton
New York
Rochester
Niagara River
0
50
miles

In Lake Ontario, yellow perch spawn from late April to July in shallow, weedy areas, in the embayments and marshes along the eastern shore; they also spawn along the lake shore proper (Balesic 1979c; Carter et al. 1977; Eckert and Schneider, pers. comm. 1979; O'Gorman, pers. comm. 1979). Resident populations of yellow perch exist in the shoreline embayments; lake residents also enter these embayments to spawn (O'Gorman, pers. comm. 1979; Skiff et al. 1950).

New York

NO-1

Oak Orchard Creek (43°22', 78°12'). The creek mouth provided excellent spawning habitat (Greene 1940).

Cranberry Pond (43°18', 77°42') and Long Pond (43°18', 77°41'). Large runs occurred here in the spring (Odell 1940).

Russell Power Station (43°16', 77°38'). In 1977, larvae were collected near shore in the vicinity of the station in mid-June and early July (Bio Systems 1978b).

Irondequoit Bay (43°14', 77°32'). Large runs of yellow perch occurred here in the spring (Odell 1940). A few young-of-the-year (YOY) were captured off the mouth of the bay in September (O'Gorman, pers. comm. 1979).

Ginna Power Station (43°17', 77°18'). In 1977, larvae were collected near shore in the vicinity of the plant in June (Bio Systems 1978a).

NO-2

Fair Haven State Park (43°20', 76°42'). In 1972, some YOY were caught here from mid-July to October (FWS, 1978).

Sterling Power Plant site (43°23', 76°39'). In 1977, yellow perch larvae were collected out to the 46 ft depth contour until late June; 89% of the catch of larvae in April and May were yellow perch (Rochester Gas Elec. Co. 1977).

Oswego (43°28', 76°31'). Eggs were entrained from Lake Ontario at the Oswego Steam Station (43°28', 76°31') in late June (Niagara Mohawk Power, undated c) and were also collected from Oswego Harbor in late June (Niagara Mohawk Power, undated b). Larvae were collected here beginning in mid-May (LMS 1976a); the harbor turning basin is a nursery area for a large part of the year (Niagara Mohawk Power, undated b).

Nine Mile Point (43°31', 76°22'). Yellow perch moved inshore here to spawn in mid- to late April (Smith 1892). A few eggs have been collected in the area (LMS 1975b, 1976b; PASNY, undated a,b). A few larvae were found here from late April to June (LMS 1975b, 1976b; Niagara Mohawk Power, undated a; PASNY, undated a,b; QLM 1974); YOY appeared in the catch in July (PASNY, undated b).

North Pond (43°39', 76°11'). Tagging studies have shown that yellow perch overwinter and spawn in North Pond, then move west to the Nine Mile Point area (43°31', 76°22'). In the fall, these fish return to North Pond (Eco Research 1978; Niagara Mohawk Power, undated d; Storr 1977). This is an important nursery area (O'Gorman, pers. comm. 1979).

Lakeview Game Management Area (43°44', 76°12'). This area, including Sandy (43°44', 76°12') and South Sandy (43°43', 76°12') creeks, is an important spawning area for yellow perch (Werner and Ford 1972).

Black Pond (43°48', 76°14'). In 1974-75, a few adults moved into the pond and into Little Stony Creek (43°48', 76°13') from April to early May (Marean 1976).

Ray Bay Marsh (43°50', 76°16'). In 1974-75, many adults entered the marsh in April (Marean 1976).

Henderson Bay (43°54', 76°10'). In 1974-75, a few adults moved into Campbell Marsh in April (Marean 1976).

NO-3

Black River Bay (43°59', 76°05'). Adults moved into Muskalonge Creek (43°59', 76°02') from mid-April to early May (Marean 1976); YOY are found in the bay (O'Gorman, pers. comm. 1979).

Sherwin Bay Marsh (43°59', 76°10'). In 1974-75, many adults entered the marsh from late March to early May, but no fry were found there (Marean 1976).

Chaumont Bay (44°03', 76°12') and Guffin Bay (44°02', 76°07'). Both lake and bay residents spawn in these bays, and YOY are found there (FWS 1978; O'Gorman, pers. comm. 1979).

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Yellow perch spawn in many of the small creeks entering the bay (Whillans, pers. comm. 1977).

Toronto (43°38', 79°25'). In 1901, ripe males were collected in May and June at Centre Island (43°37', 79°22'). In 1891, spawning was completed in Ashbridges Bay (43°40', 79°19') by April 23 (Dymond et al. 1929).

OO-2

Rouge River (43°48', 79°07') and Pickering (Duffin) Creek (43°49', 79°02'). In 1912, it was reported that fishing at the tributary mouths was spoiled because carp ate the yellow perch spawn (Ont. Game Fish 1912).

McLaughlin Bay (43°52', 78°48'). This is a spawning area (Balesic 1979c).

OO-3

Prince Edward County Peninsula (44°00', 77°15'). Spawning occurs in sheltered areas from Wellers Bay east along the south shore (Balesic 1979c); areas specifically identified are:

> Wellers Bay (44°00', 77°35'). Head of the bay at 44°00', 77°32' (Whillans, pers. comm. 1979).
>
> Huycks Point (43°56', 77°29'). Wellington Bay (43°56', 77°21'). From the village of Wellington (43°57', 77°21') to West Owen Point (43°53', 77°17') (Environ. Can. 1977a).

South Bay (43°56', 77°02'). Along west shore. Black River (43°58', 77°02'). Smith Bay (44°00', 77°01'). Along northwest shore (Whillans, pers. comm. 1979).

Amherst Island (44°09', 76°43'). Wemps Bay (44°07', 76°47') is a major spawning area (Dunford 1979).

Wolfe Island (44°10', 76°25'). Spawning occurs in several shoreline areas (Environ. Can. 1977a); areas specifically identified are:

> Horseshoe Island (44°09', 76°31'). Sand Bay (44°09', 76°31')--Yotts Point (44°08', 76°29'). Reeds Bay (44°08', 76°29'). Back of bay. Long Point (44°06', 76°29'). South shore (Whillans, pers. comm. 1979).

00-4

Bay of Quinte (44°08', 77°15'). In 1974, yellow perch larvae were found throughout the bay in mid-May and early June; greatest densities were found in upper Hay Bay (44°10', 76°56') and the upper Bay of Quinte, indicating that spawning occurred in the warmer waters in the upper reaches of the bay (Lam 1977). Spent or partly spent females were found in the Bay of Quinte from early May through June (Sheri and Power 1969).

Lennox Generating Station (44°09', 76°51'). Trap net catches at the station and to the west at Sandhurst (44°08', 76°52') and to the east at the cement plant (44°10', 76°48') showed that adults began to move inshore in about mid-April at water temperatures of 34-36°F, and that by late April, large numbers were present nearshore at these locations (Griffiths 1976b). The presence of ripe and spent fish and of egg strands showed that spawning occurred at these locations and also in the discharge canal of the station from late April through May at water temperatures of 37-55°F (Dunford 1978a; Griffiths 1976b). Egg strands were almost always found among aquatic plants, such as Myriophyllum (Griffiths 1976b). Yellow perch often spawned in the discharge canal, but spawning in the canal was often unsuccessful (Balesic 1978). Trap net catches west of the station indicated a pre-spawning movement into the Bay of Quinte and an eastward, post-spawning movement out of the bay in late May (Dunford 1976b). Larvae were widely distributed in the area, but were most abundant at Sandhurst (Dunford 1978a; Griffiths 1976b).

Upper Gap (44°07', 76°49'). Larger numbers of adults and larvae were found in this area than along the north shore (Dunford 1979). Pig Point (44°08', 76°49') is a major spawning area; many eggs were found there from late April to early June among aquatic plants at depths of 6-20 ft; the water temperature in late April was 37°F (Dunford 1978a; Griffiths 1976b). Densities of larvae were higher at Pig Point than elsewhere in the area (Griffiths 1976b).

00-5

Collins Bay (44°14', 76°37'). Spawning occurs in the shallow areas of the bay (Whillans, pers. comm. 1979).

SAUGER

Ontario

OO-1

Burlington Bay (43°17', 79°50'). Saugers spawned in the rivers entering the bay. They were abundant until the mid-1870s, but the runs declined by the turn of the century (Whillans 1977).

Toronto Bay (43°38', 79°23'). Saugers spawned in the rivers entering the bay. The population declined by the 1870s and never recovered. In 1913, the sauger was listed as rare (Whillans 1977).

BLUE PIKE

The blue pike was once an abundant and commercially important fish in the lower Great Lakes. Populations of blue pike were mainly confined to western and southern Lake Ontario, central and eastern Lake Erie, and the Niagara River (Blue Pike Recovery Team 1975). It is hypothesized that the blue pike in Lake Ontario originated in Lake Erie. The fishery for blue pike in Lake Ontario collapsed in about 1955, just prior to the collapse of the fishery for blue pike in Lake Erie (Christie 1973). The last confirmed catch of blue pike in the lower Great Lakes was made in 1965 (Blue Pike Recovery Team 1975). In Lake Ontario, blue pike spawned over rocky or sand and mud substrate at depths of 15-130 ft and water temperatures of 38-48°F (Cahill, pers. comm. 1977; Stone 1948), possibly as late as July (Rathbun and Wakeham 1897).

New York

NO-1

Niagara County (43°17', 78°55'). In 1946 and 1947, adults in spawning condition were found at several locations between the Niagara River (43°16', 79°04') and Olcott (43°20', 78°43') from late April to early May. The catches often included ripe females surrounded by several milting males. A movement westward along the shore was observed during spring and early summer. Adults were first caught in early March, just east of Olcott in 60-90 ft of water; they remained near Olcott Harbor for about a month and then began moving westward in late April, always at depths greater than 40 ft. By mid-May, the migration passed Wilson (43°19', 78°50') and by early June reached Niagara Bar where the adults remained for a few weeks. The adults disappeared from catches about July 1 (Stone 1948).

NO-2

Selkirk (43°33', 76°12'). Blue pike appeared in deep water here in early spring (Stone 1948).

NO-3

Chaumont Bay (44°03', 76°12'). Spawning occurred here (Cahill, pers. comm. 1977).

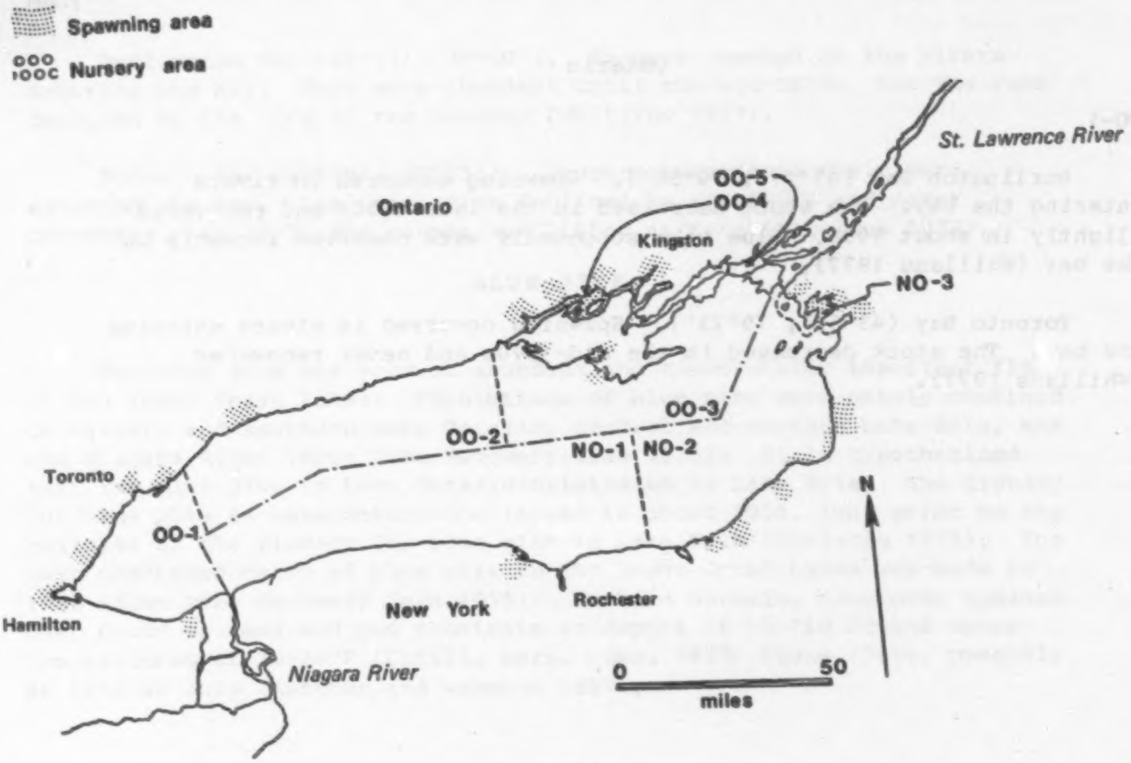
Ontario

OO-1

Burlington Bay (43°17', 79°50'). Spawning occurred in rivers entering the bay. The stock decreased in the late 1800s and recovered slightly in about 1930. Blue pike supposedly were observed recently in the bay (Whillans 1977).

Toronto Bay (43°38', 79°23'). Spawning occurred in rivers entering the bay. The stock decreased in the mid-1870s and never recovered (Whillans 1977).

WALLEYE


Spawning area
Nursery area
St. Lawrence River
OO-5
OO-4
Ontario
Kingston
NO-3
OO-3
OO-2
NO-1
NO-2
Toronto
N
OO-1
Rochester
New York
Hamilton
Niagara River
0
50
miles

Historically, walleyes moved inshore to spawn in creeks, river mouths, and along the shoreline in April (Nash 1913; Rathbun and Wakeham 1897; Smith 1892; Stone 1948).

New York

NO-1

Long Pond (43°18', 77°41'). A spawning run occurred here (Odell 1940).

NO-2

Port Bay (43°18', 76°50'). A spawning run occurred here (Odell 1940).

Blind Sodus Bay (43°20', 76°44'). This is a spawning area (NYDEC 1977b; Odell 1940). In 1942, running-ripe males and females were found over stone and sand in 4 ft of water in mid-April at the mouth of the bay (Stone 1948).

Oswego River (43°28', 76°31'). In the spring walleyes concentrate below the lowermost dam on the river (N.Y. State Dept. Conserv., undated c).

Nine Mile Point (43°31', 76°22'). Eggs were entrained at the Fitzpatrick Power Plant (43°31', 76°24') and collected in the vicinity of the plant in late May (PASNY, undated a,b).

South Sandy Pond (43°37', 76°11'). Spawning was observed at the pond outlet; in 1947, running-ripe adults were seen along the east shore over stone and sand in 3-8 ft of water in mid-April at temperatures of 42-43°F (Stone 1948).

North Pond (43°39', 76°11'). Fishermen reported that runs entered North Pond and Lindsey (43°40', 76°10') and Skinner (43°41', 76°10') creeks, but there is no evidence of successful reproduction (Schneider, pers. comm. 1979).

NO-3

Historically, spawning occurred around almost all the islands at the eastern end of the lake (Rathbun and Wakeham 1897).

Black River Bay (43°59', 76°05'). In the late 1800s, no spawning occurred in the bay or lower portion of the Black River (44°00', 76°04') because of pollution from mills at Watertown (Rathbun and Wakeham 1897). Hatchery records, however, show that a spawning run occurred in the bay and river around 1900 (Schneider, pers. comm. 1979).

Chaumont Bay (44°03', 76°12'). Historically, extensive spawning grounds were located here; the bay was one of the two major spawning areas in the lake (Hile, pers. comm. 1979; Rathbun and Wakeham 1897; Schneider, pers. comm. 1979). Spawning grounds also existed in Three Mile Bay (44°04', 76°13') (Rathbun and Wakeham 1897).

Mud Bay (44°05', 76°19'). Historically, ripe adults were collected in tributaries to the bay (Schneider and Leach 1979). In the early 1900s, spawning occurred in Mud (Kents) Creek (44°05', 76°19') (Schneider, pers. comm. 1979). In 1911, eggs were first collected in Mud Creek in late April, about 3 weeks later than normal, due to heavy ice (Bean 1912).

Ontario

OO-1

Martindale (Twelve Mile) Creek (43°10', 79°16'). Historically, many walleyes were seined in the creek in early April (Kerr and Kerr 1860-1898).

Burlington Bay (43°17', 79°50'). Around 1840, walleyes were common in the bay during spawning season (Dymond et al. 1929); until the late 1870s or early 1880s, they spawned in tributaries to the bay. The population increased slightly until about 1930, but spawning no longer occurs in the bay (Whillans 1977).

Bronte Creek (43°24', 79°43'), Oakville Creek (43°26', 79°40'), Port Nelson (location unknown), Credit River (43°33', 79°35'), Mimico Creek (43°37', 79°29'), and Humber River (43°38', 79°28'). Spring spawning runs occurred here (Kerr and Kerr 1860-1898).

Don River (43°39', 79°21'). During the late 1860s, spawning still occurred here, but after 1874 the population essentially disappeared (Kerr and Kerr 1860-1898; Whillans 1977).

OO-2

Rouge River (43°48', 79°07'), Duffin Creek (43°49', 79°02'), and Lynde Creek (43°51', 78°57'). Spring spawning runs historically occurred in these tributaries (Kerr and Kerr 1860-1898).

OO-3

Prince Edward County Peninsula (44°00', 77°15'). Spawning areas here include (Whillans, pers. comm. 1979):

> Wellers Bay (44°00', 77°35'). East shore of Sugar Point (44°00', 77°34'); a large run also enters the stream flowing out of Consecon Lake (44°00', 77°30').
>
> West Lake (43°56', 77°17'). In the creek between Poplar and Gasket Islands (43°57', 77°17'), along the northwest shore of Tubbs Island (43°56', 77°16'), and along shore south of Tubbs Island (43°55', 77°16').
>
> East Lake (43°55', 77°12'). Along the southeast shore north of Parr Island (43°54', 77°12').

OO-4

Bay of Quinte (44°08', 77°15). Historically, the bay was one of the two major spawning areas in the lake (Hile, pers. comm. 1979), and spawn was collected from ripe fish in the bay (Ont. Game Fish 1943). Spawning occurred in the lower sections of tributaries and on shoals and along rocky shorelines in Hay Bay (44°07', 77°01') and the upper bay (Christie 1973; Int. Great Lakes Levels Board 1973; Leach et al. 1977; Ont. Game Fish 1945; Ont. Min. Lands Forests 1948; Payne 1964; Schneider and Leach 1979). "Pickerel" spawned at Twelve O'Clock (44°04', 77°35'), Wallbridge (44°09', 77°21'), Massasauga (44°09', 77°19'), Horse (44°09', 77°18'), Ox (44°09', 77°19'), and Anne (44°09', 77°18') points in the upper bay; along the north shore of Big Island east from Richson Point (44°06', 77°17'); at unnamed sites (44°07', 77°02' and 44°10', 76°56') in Hay Bay; and in Long Reach (44°08', 77°04') (Environ. Can. 1977a). Spawning occurred at water temperatures of 35-50°F in April (Payne 1964). The walleye population declined in the 1960s after white perch invaded the area (Schneider and Leach 1977), and now spawning occurs only in tributaries (Leach et al. 1977). Spawning occurred in the four major tributaries; the Trent (44°06', 77°34'), Moira (44°09', 77°23'), Salmon (44°11', 77°15'), and Napanee (44°12', 77°01') rivers, just below the dams (Can. Fisherman 1924a; Hurley 1972b; Ont. Dep. Lands Forests 1971; Ont. Game Fish 1910, 1913b; Payne 1964). The run in the Trent River was the last to decline and is still producing at a low level (Christie 1973; Schneider and Leach 1979). Spawning still occurs at the mouths of the Trent and Moira Rivers (Environ. Can. 1977a). An extensive post-spawning migration occurs out of the bay (Payne 1964; Schneider and Leach 1977). One walleye tagged in the upper bay was recovered 48 mi away on the south shore of Prince Edward County (44°00', 77°15'). Walleyes return to the bay in the fall (Payne 1964; Schneider and Leach 1979). In 1974, a few larvae were collected in the bay in mid-May (Lam 1977). Young remain in the bay for 3 years and then migrate to the lake (Schneider and Leach 1979).

PERCIDAE spp.

New York

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1977, percid eggs were collected here in early July (Rochester Gas Elec. 1977).

FRESHWATER DRUM

In Lake Ontario, freshwater drum reproduction is limited because the water temperature reaches the spawning temperature of 70°F for only a short time (Daiber 1950). Spawning occurs in nearshore waters in July and August (Bio Systems 1978a).

New York

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1977, a few freshwater drum eggs were collected in the vicinity in late June and late July (Rochester Gas Elec. 1977).

Oswego River (43°28', 76°31'). A substantial spawning run enters the river during June (O'Gorman, pers. comm. 1979).

NO-3

Chaumont Bay (44°03', 76°12'). In 1979, young-of-the-year were found in the western part of the bay (O'Gorman, pers. comm. 1979; Schneider, pers. comm. 1979).

Ontario

OO-4

Bay of Quinte (44°08', 77°15'). Freshwater drum are most abundant in the warm, shallow waters of the bay (Daiber 1950). Spawning occurs in the bay in July and August. In 1974, eggs were collected from early July to mid-August; one larva was also found (Lam 1977).

MOTTLED SCULPIN

New York

NO-2

Oswego (43°28', 76°31'). In 1974-76, larvae were collected from late June to September; up to 56% of the larvae in samples taken near the bottom in late June were mottled sculpins (LMS 1976a, 1977b).

Nine Mile Point (43°31', 76°22'). In 1973-76, mottled sculpin larvae were one of the most abundant larvae collected in the area; they were present from mid-June to mid-September and peak abundance occurred in late June. Most larvae were longer than about 0.2 in., but some smaller than 0.1 in. were present in late June (LMS 1975b, 1976b; PASNY, undated b; QLM 1974).

SLIMY SCULPIN

In Lake Ontario, slimy sculpins spawn in deep water throughout the lake (Eckert and Schneider, pers. comm. 1979). Adults are ripe in April and May (O'Gorman, pers. comm. 1979) and usually spawn in June (Schneider, pers. comm. 1979). Eggs were found in the eastern end of the lake on a log retrieved in a trawl in June (Schneider, pers. comm. 1979).

New York

NO-1

Rochester (43°15', 77°35'). In 1979, young-of-the-year were found in 66 ft of water off Rochester in September (O'Gorman, pers. comm. 1979).

Ontario

OO-3

Pleasant Point (44°07', 76°42'). In 1928, a ripe female was collected off the point in late May (Hubbs and Brown 1929).

SCULPIN spp.

New York

NO-1

Russell Power Station (43°16', 77°38'). In 1977, 20% of the total catch of benthic larvae were sculpins; most were collected in early July (Bio Systems 1978b).

NO-2

Sterling Power Plant site (43°23', 76°39'). In 1974 and 1977, sculpin larvae were collected near the bottom from mid-June to early August (LOTEL 1977; Rochester Gas Elec. 1977).

50272-101

REPORT DOCUMENTATION PAGE

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5. Report Date September 1982

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7. Author(s) Goodyear, C.D., T.A. Edsall, D.M. Ormsby Dempsey, G.D. Moss, and P.E. Polanski

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14.

15. Supplementary Notes

This document is one of a set of fourteen volumes.

16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

17. Document Analysis a. Descriptors

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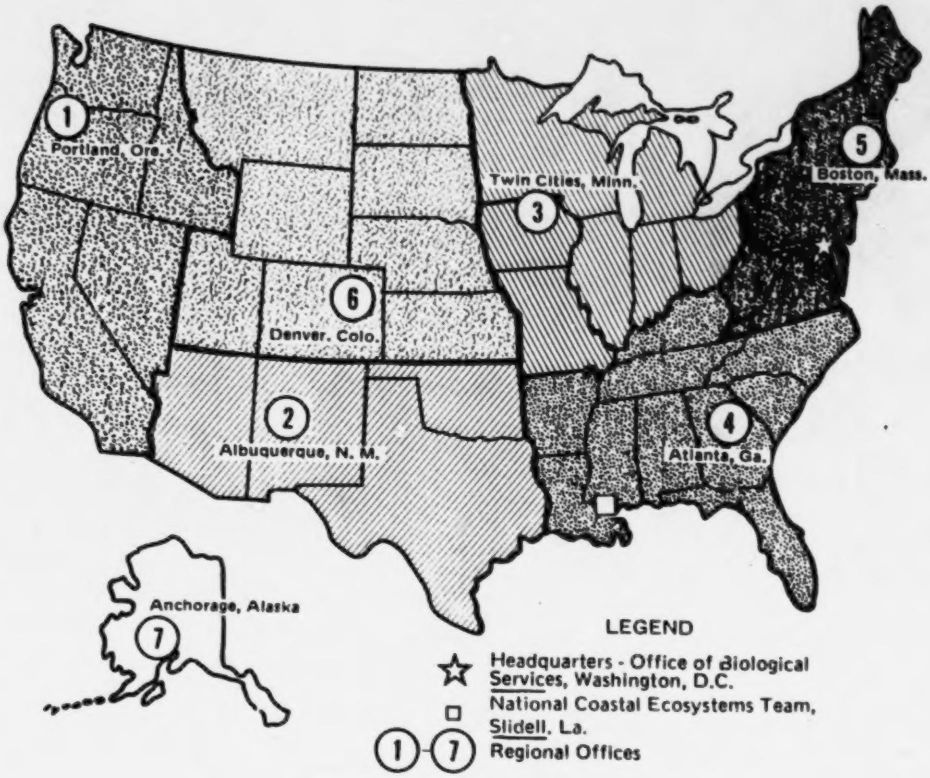
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ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume XII-St. Lawrence River

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME XII

St. Lawrence River

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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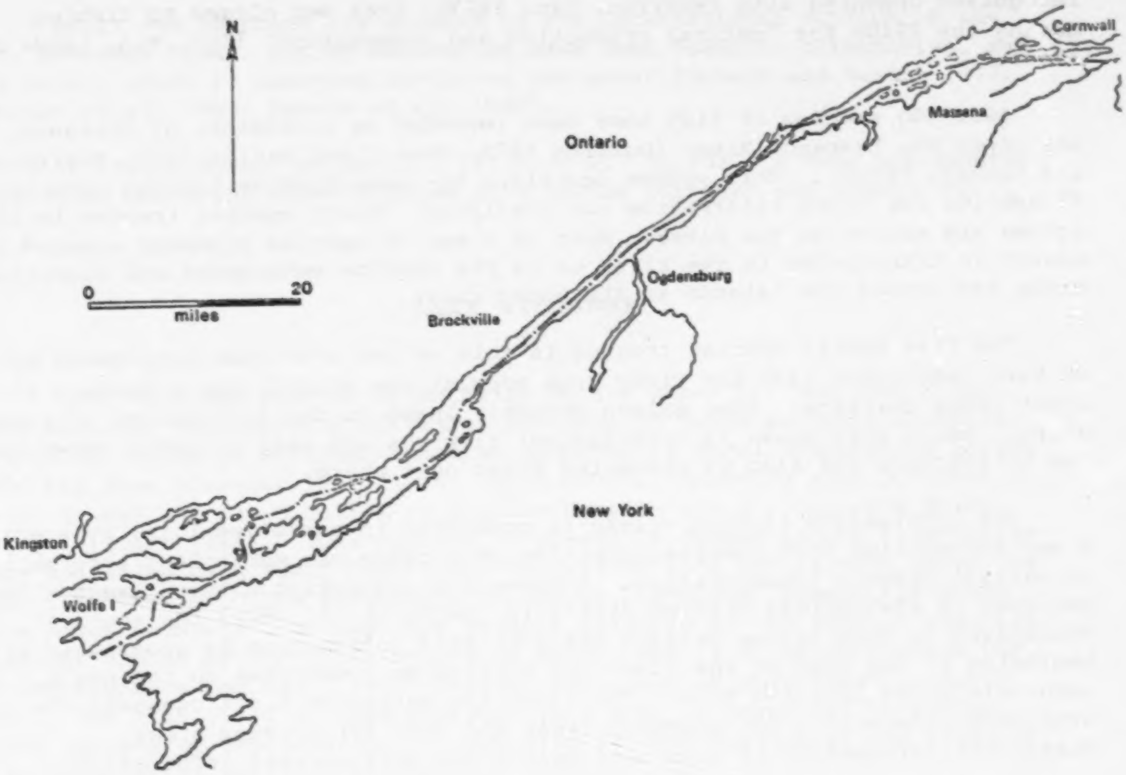
INTRODUCTION



The St. Lawrence River forms the connecting waterway between Lake Ontario and the Atlantic Ocean. Only the international section of the river is considered in this atlas. The important breeding habitats in the international section of the St. Lawrence River are the inshore areas, including the extensive wetlands and marshes, and the tributary streams (Geis and Hyduke 1978; LMS 1977; SLEOC 1978; Werner and Ford 1972). Historically, the tributaries, which warm earlier than the main stem of the river, were very important spawning grounds for many St. Lawrence fish species, which often ran long distances upstream (Greeley 1934; Greeley and Greene 1931; Greene et al. 1932; Hazzard 1931). Young fish remained in the creek mouths for some period of time before moving into the river (Greeley and Greene 1931). Heavily used tributaries included the Oswegatchie River (Greene et al. 1932), Raquette River (Greeley 1934), and St. Regis River (Hazzard 1931). The habitats and migration patterns of St. Lawrence River fishes have been drastically altered by the extensive dam construction which has occurred on the river. In the early 1930s, dams were reported to stop spawning runs on the Grass and St. Regis Rivers (Hazzard 1931). Presently, in addition to the Moses-Saunders Dam on the main river at Cornwall, every major tributary is dammed within 20 mi of its mouth (SLEOC 1978). The river mouths, including that of the Oswegatchie River, are still important spawning areas (Geis and Hyduke 1978). Among the many shoreline bays that are valuable for reproduction, Landons Bay (44°21'15", 76°03'50"), on the Canadian shore opposite Wellesley Island, is a long recognized spawning site (Environ. Can. 1977b) that was closed to fishing during the 1940s for "natural production and propagation" (Ont. Min. Lands For. 1948).

Over 100 species of fish have been recorded as residents, or migrants, in the upper St. Lawrence River (Dunning 1979; Eckert and Hanlon 1977; Evermann and Kendall 1902a). This volume describes the reproductive habitat used by the 45 species for which information was available. Forty species treated in this volume are native to the river. Most of these 40 species probably spawned (or spawn) in tributaries to the river or in the shallow embayments and shoreline areas and around the islands in the upper river.

The five exotic species treated in this volume have been introduced by man or have immigrated into the river from populations established elsewhere in the Great Lakes drainage. Coho salmon probably spawn in the tributaries or along shore. Smelt also spawn in tributaries; alewives and carp probably spawn in the tributaries and also in protected areas near shore.

The information in this volume is presented in narrative form, by species. A map accompanies each species narrative when there was sufficient information to warrant graphic summarization. Because the connecting waters have not been assigned to statistical fishing districts (Smith et al. 1971) the species narratives in this volume present the available information by geographic area beginning at the head of the river and continuing downstream to the mouth. For each referenced location within the river the narrative first presents the available information for spawning areas and then for nursery areas. Historical information is presented before the more current information.

For the purposes of this atlas, we defined the head of the river as that portion of the river immediately downstream from a line connecting Tibbetts Point (44°06'00", 76°22'15") and Point Frederick (44°13'25", 76°28'15"). The lower boundary of the international section of the river is a line connecting the mouth of the St. Regis River (45°00'00", 74°38'20") and Farlingers Point (45°01'40", 74°39'35").

SEA LAMPREY

Adult sea lampreys are present in the international portion of the St. Lawrence River, but no ammocoetes have been found in tributaries, and it is not known if spawning occurs in the river (Eckert and Hanlon 1977; Morman et al. 1980; Pearce et al. 1980).

St. Regis River (45°00'10", 74°38'20"). In 1930, a dead sea lamprey was found below the lower riffles in mid-June (Greeley and Greene 1931).

LAKE STURGEON

Lake sturgeon entered tributaries of the upper St. Lawrence River and migrated considerable distances upstream to reach suitable spawning areas in rapids or riffles; spawning occurred in these tributaries during May and June (Currier 1945, 1946; Smith 1892). Spawning also occurred over gravel and stone bottom in shallow bays in the St. Lawrence River proper (Toner 1943). This species is presently common in the river below the Moses-Saunders Power Dam (45°00'25", 74°47'45") but is rare above the dam (SLEOC 1978). The population in the St. Lawrence, especially above the Moses-Saunders Dam, has been greatly affected by the loss of spawning habitat caused by the construction of dams. The 10 mi section below the Moses-Saunders Dam has a swift current and could provide spawning habitat. The high catch of lake sturgeon less than 10 years old indicates that successful reproduction is occurring in this section of the river or its tributaries (Jolliff and Eckert, undated).

Morristown (44°35'20", 75°29'55"). Spawning historically occurred here in 10-15 ft of water over sand (Jolliff and Eckert, undated).

Oswegatchie River (44°41'45", 75°30'00"). This was an historical spawning area (Jolliff and Eckert, undated).

Massena Intake Dam (44°57'25", 74°55'25"). In 1970, a ripe male was found on June 18 (Jolliff and Eckert, undated).

Moses-Saunders Power Dam (45°00'25", 74°47'45"). In 1970, 27 ripe males were found just below the dam on June 11-19, at water temperatures of 62-64°F (Jolliff and Eckert, undated). During the early 1940s, lake sturgeon were speared in the early summer as they ran into swift water at Cornwall (45°01'00", 74°44'00"), probably for spawning (Toner 1943).

Grass River (44°59'15", 74°46'15"). The river has limited spawning areas below the dam (Jolliff and Eckert, undated).

Raquette River (45°59'40", 74°41'15"). This was an historical spawning area (Greeley 1934). The NYDEC has recently found lake sturgeon in the river (R. Werner, pers. comm. 1979); this river is unobstructed for 19 mi and has several riffle areas (Jolliff and Eckert, undated).

St. Regis River (45°00'10", 74°38'20"). The river has limited spawning areas below the dam at Hogansburg (Jolliff and Eckert, undated).

LONGNOSE GAR

Ogdensburg (44°42'00", 75°29'30"). Historically this species moved onto shoals at Ogdensburg for spawning around May 20 (Goode 1884).

Little Sucker Brook (44°52'00", 75°11'05"). Young were found at the mouth of the brook in July (Greeley and Greene 1931).

Grass River (44°59'15", 74°46'15"). Young were found in the lower river in July (Greeley and Greene 1931).

BOWFIN

Cornwall (45°00'45", 74°44'00"). Almost 4,000 fingerlings were collected from a single large school in the river near Cornwall (Toner 1937).

AMERICAN EEL

American eels are abundant in the St. Lawrence River in September and October during their migration from Lake Ontario to spawning grounds in the Atlantic Ocean (Greeley and Bishop 1932; Hurley 1972a); these adults are often killed in turbines at the Moses-Saunders Power Dam (45°00'25", 74°47'45"). Young eels moving upstream are often concentrated below the dam (Eckert and Hanlon 1977, GLFC 1964). The interruption of these migrations in the river will ultimately affect the population in Lake Ontario (LMS 1977).

ALEWIFE

The alewife presumably entered the St. Lawrence River from the Atlantic Ocean or Lake Ontario. The time of its first appearance in the river is unknown. The inshore zone and tributaries along the entire New York shoreline of the St. Lawrence River are spawning and nursery areas for alewives (LMS 1977; Schneider, pers. comm. 1979; Werner and Ford 1972). Inshore movement and spawning begin in the warmer embayments in April or May and continue into July; young-of-the-year are in the nearshore waters throughout the summer (Eckert, pers. comm. 1979; NALCO

1978). Alewife larvae dominate the ichthyoplankton in the river (FWS 1979d). Young were seined in creek mouths and along the river shore in September (Greeley and Greene 1931).

Tibbets Point (44°06'00", 76°22'15")--Thousand Island Bridge (44°18'05", 75°58'55"). Spawning was observed off the dock in Cape Vincent Harbor (44°07'50", 76°20'00") (Eckert, pers. comm. 1979) and also probably occurred along shore at Cape Vincent where several alewife larvae were collected in July (Haynes et al. 1979). In 1976, alewife larvae were 94% of the catch in the Tibbets Point--Thousand Island Bridge area in July and August. An extended period of continuous spawning occurred. Larvae were widely distributed in both littoral and open areas (Werner 1977).

Oswegatchie River (44°41'45", 75°29'55"). In 1878, thousands of alewives entered the river in June, a few days after ripe adults were collected near Ogdensburg (44°42'00", 75°29'30") (Bean 1884b).

Brandy Brook (44°52'50", 75°09'45"). In 1978, one alewife egg was collected in the channel off the mouth of the creek on May 10 (NALCO 1978).

Waddington (44°52'00", 75°12'10"). Ripe adults were collected near Waddington at the end of May (Bean 1884b).

MOONEYE

Oswegatchie River (44°41'45", 75°29'55"). Eggs were found in early June just below the Oswegatchie Dam, among rocks in rapidly flowing water less than 2 ft deep; the water temperature was 67°F (Greeley and Bishop 1932).

Tibbits Creek (44°43'50", 75°26'05"). Adults in spawning condition were collected at the mouth of the creek in early July (Greeley and Greene 1931).

LAKE HERRING

Adult lake herring were not considered permanent residents of the St. Lawrence River and were not commonly found as far downstream from Lake Ontario as were the young fish. The young fish found in the river were considered downstream migrants from Lake Ontario (Greeley 1934; Greeley and Greene 1931). Young lake herring were collected at the following locations.

Ogdensburg (44°42'00", 75°29'30"). Young lake herring about 1 inch long were found along shore at the Ogdensburg hatchery over sand and boulders in only a few inches of water during June (Greeley and Greene 1931).

Waddington (44°52'00", 75°12'10"). A school of young were found in 3 ft or less of water at the foot of the rapids in late June (Greeley and Greene 1931).

Franklin-St. Lawrence County line (44°59'15", 74°44'00"). Young were dip-netted from the river (Greeley 1934).

LAKE WHITEFISH

Ogdensburg (44°42'00", 75°29'30"). One young-of-the-year (YOY) about 1.3 in. long was found in mid-June in association with YOY lake herring at the boat house at the Ogdensburg hatchery (Greeley and Greene 1931).

COHO SALMON

No record of coho salmon plantings in the St. Lawrence River was found; those found in the river are assumed to have originated from plantings in Lake Ontario. Two spawning areas have been identified (Whillans, pers. comm. 1979).

Treasure Island (44°15'30", 76°22'20"). East shore.

Howe Island (44°16'00", 76°16'00"). South shore of Cassidys Bay (44°15'45", 76°20'45").

ATLANTIC SALMON

In the 1820s, Atlantic salmon were abundant in every tributary of the St. Lawrence River, but by 1859 the species was nonexistent downstream to Quebec (Adamson 1857). Historically, they migrated up the river from the sea (Bean 1903). In the international portion of the river, Atlantic salmon spawned in the following rivers (Edmunds 1874).

Oswegatchie River (44°41'45", 75°29'55").

Grass River (44°59'15", 74°46'15").

Raquette River (44°59'40", 74°41'15").

St. Regis River (45°00'10", 74°38'20").

LAKE TROUT

Cape Vincent (44°07'45", 76°20'00"). Eggs were collected from ripe lake trout in the area during November (Bean 1912).

RAINBOW SMELT

Rainbow smelt were first reported in the upper St. Lawrence River in 1939, when a run entered the Gananoque River (Toner 1940). The inshore waters and tributaries of the St. Lawrence provide spawning and nursery habitat (LMS 1977).

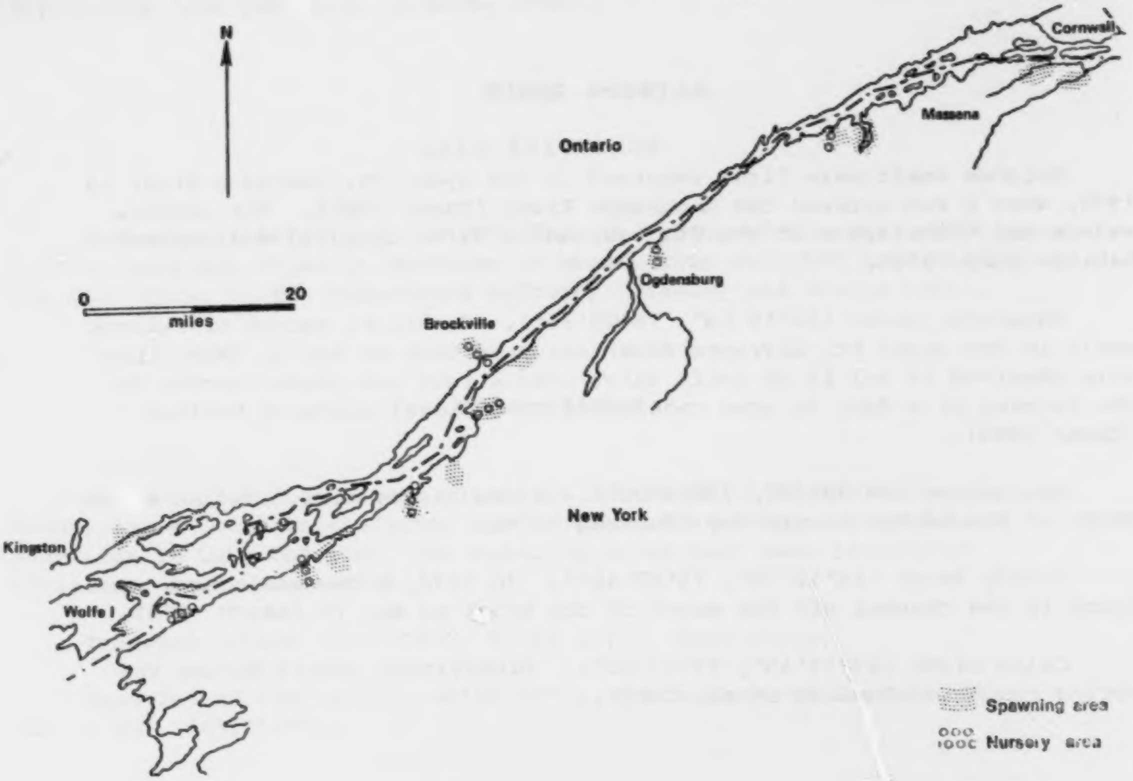
Gananoque River (44°19'30", 76°09'35"). The first record of rainbow smelt in the upper St. Lawrence River occurred here on May 4, 1939; they were observed in 2-3 ft of swift water over a rock and gravel bottom in the raceway of a dam, an area considered to be ideal spawning habitat (Toner 1940).

Morristown (44°35'20", 75°39'00"). A few larvae were found at the mouth of the harbor in mid-May (Dunning 1979).

Brandy Brook (44°52'50", 75°09'45"). In 1978, a few smelt eggs were found in the channel off the mouth of the brook on May 10 (NALCO 1978).

Coles Creek (44°53'45", 75°07'05"). Dip-netting occurs during the spring run here (Dunning et al. 1978).

NORTHERN PIKE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Wolfe I
Spawning area
Nursery area

In the St. Lawrence River, almost every marsh and stream has a spawning population of northern pike (Eckert, pers. comm. 1979; FWS 1979d). Spawning occurs in marshes and along flooded shorelines (Eckert and Hanlon 1977), and spawning runs also enter creeks (Greeley and Greene 1931). Presently, spawning success is affected by low and fluctuating water levels (Int. Great Lakes Levels Board 1973). Along the St. Lawrence River shore, small marshes are usually more productive than larger ones. A good spawning marsh has a central channel with a slow flow and flooded shallow areas along shore, an average depth of not more than about 1.6 ft, dead and decaying vegetation on the bottom, and a supply of fathead minnows as food for the young (Marean 1976).

Wolfe Island (44°10'00", 76°25'00"). The island provides many spawning sites for northern pike (Environ. Can. 1977b). Spawning occurs at the following locations.

Hinckley Point (44°08'30", 76°21'25"). Button Bay (44°08'55", 76°22'00") and Bayfield Bay (44°11'35", 76°21'00"). Heads of the bays. Lewis Bay (44°12'35", 76°16'05") and Murray Bay (44°12'30", 76°15'25"). Irvine Bay (44°13'40", 76°16'30"). Head of bay (Whillans, pers. comm. 1979).

Millen Bay Marsh (44°10'15", 76°14'45"). In 1974-75, a few adults entered the marsh in mid-April, and a few fry were found there in early July (Marean 1976).

Madoma Marsh (44°15'45", 76°22'45"). Spawning occurs in the marsh and bays (Whillans, pers. comm. 1979).

Chipmans Bay (44°17'15", 76°18'55"). Spawning occurs along the shore south of the bay (Whillans, pers. comm. 1979).

Firmans Point (44°18'25", 76°14'15"). In 1964, one spent and one partly spent female were found in early May; in 1965, a ripe female was found in May (Casselman 1967).

Howe Island (44°15'35", 76°16'35"). Spawning occurs at the head of Quinn Bay (44°15'30", 76°16'30") (Whillans, pers. comm. 1979).

Grindstone Island (44°17'00", 76°07'00"). Flynn Bay (44°15'15", 76°08'10"), McCrea Bay (44°17'00", 76°07'50"), and Delaney Bay (44°17'45", 76°05'20") are spawning and nursery areas (SLEOC 1978; R. Werner, pers. comm. 1979; Werner and Ford 1972).

French Creek (44°14'00", 76°05'20"). Spawning occurred in the lower section of the creek (Greene et al. 1932). In 1974-75, many northern pike were observed moving upstream in the upper creek and its tributary in late March and April. Fry moved downstream in June and July, and this was classified as a good spawning area (Marean 1976; R. Werner, pers. comm. 1979).

Blind Bay Marsh (44°16'00", 76°01'00"). This cattail marsh is a spawning area (Werner and Ford 1972).

Mullett Creek (44°16'35", 76°00'15"). In 1974-75, a few adults moved into the creek in April, but only one fry was found in early July, and the creek was classified as a poor spawning area (Marean 1976).

Swan Bay (44°18'20", 75°58'00"). This spawning area consists primarily of cattail marsh and some submerged aquatic vegetation (Werner and Ford 1972).

Point Vivian (44°19'00", 75°57'05"). This area contains good spawning habitat and may be a spawning area (Werner and Ford 1972).

Cranberry Creek (44°21'15", 75°52'00"). Spawning occurred in the lower section of the creek (Greene et al. 1932). In 1974-75, many adults were observed moving upstream in April; fry moved downstream in June. This creek was classified as a good spawning area (Marean 1976).

Crooked Creek (44°24'20", 75°48'10"). Spawning occurs here (SLEOC 1978).

Chippewa Creek (44°27'10", 75°45'30"). Spawning occurs here, especially in the lower 4 mi of the creek (Greene et al. 1932; SLEOC 1978). In 1978, a few young-of-the-year were found along shore at the mouth of the creek (Dunning et al., undated).

Jones Creek (44°30'15", 75°48'10"). In 1965, collections of ripe adults indicated a large spawning run. Young-of-the-year move out of the creek and into the river in late summer and fall (Casselman 1967).

Louce Creek Marsh (44°35'00", 75°38'55"). This is an important spawning area; many adults in spawning condition were captured here in 1978 (Geis and Hyduke 1978).

Morristown Point (44°36'00", 75°38'25"). Based on high catches of adults in the spring, spawning may occur just downstream from the point when conditions are favorable (Dunning et al., undated).

St. Lawrence State Park (44°38'15", 75°34'15"). Based on high catches of adults in the spring, spawning may occur here when conditions are favorable (Dunning et al., undated).

Tibbits Creek (44°43'50", 75°26'05"). Young northern pike were found in the creek in the summer (Greeley and Greene 1931). In 1978, a large spring run occurred here (Dunning et al. 1978; Geis and Hyduke 1978).

Sucker Brook (44°52'10", 75°11'45"). This is a spawning area (SLEOC 1978), and young pike were found in the creek in the summer (Greeley and Greene 1931).

Brandy Brook (44°52'50", 75°09'45"), Coles Creek (44°53'45", 75°07'05"), and Grass River (44°59'15", 74°46'15"). Spawning occurs here (SLEOC 1978).

Raquette River (44°59'40", 74°41'15"). Northern pike ran upstream as far as the dam at Raymondville; young fish were present in the river's lower tributaries, including Squeak River and Hutchin's Brook (Greeley 1934).

MUSKELLUNGE

The muskellunge probably spawns in marshy areas throughout the river (Eckert, pers. comm. 1979). In the St. Lawrence River, the temperature at which spawning occurs (65°F) is not reached until mid-June (Sauve and Fowler 1961).

Wolfe Island (44°10'00", 76°25'00"). Spawning occurs at the following locations. Browns Bay (44°13'15", 76°24'10"). Head of the bay. McDonnell Bay (44°13'40", 76°23'00"). Head of the bay. The bay just east of McDonnell Bay (44°13'35", 76°22'05") (Whillans, pers. comm. 1979).

Crooked Creek (44°24'20", 75°48'10") and Chippewa Creek (44°27'00", 75°45'30"). Spawning occurs at the creek mouths (SLEOC 1978).

Ogdensburg (44°42'00", 75°29'30"). Several small muskellunge (age not given) were observed at the hatchery dock (Greeley and Greene 1931).

Tibbits Creek (44°43'50", 75°26'05") and Little Sucker Brook (44°52'00", 75°11'05"). Several small muskellunge (age not given) were observed at the mouths of these streams (Greeley and Greene 1931).

CARP

The time of the first appearance of carp in the St. Lawrence River is unknown. Carp were present in the St. Lawrence River prior to 1900; presumably these originated from populations in Lake Ontario or from plantings made in New York as early as 1879 (McCrimmon 1968).

Millen Bay Marsh (44°10'15", 76°14'45"). In 1974-75, carp fry were abundant in the marsh during early June through July (Marean 1976); the marsh is a nursery area (R. Werner 1977; pers. comm. 1979).

Tibbits Creek (44°43'50", 75°26'05"). Carp spawned in the lagoon at the creek mouth (Greeley and Greene 1931).

Ogdensburg (44°42'00", 75°29'30")--Massena (44°56'00", 74°53'00"). In this section of the river, carp spawn in less than 2 ft of water in flooded marsh areas; fluctuating water levels often reduce spawning success (Int. Great Lakes Levels Board 1973).

Upper Canada Bird Sanctuary Marsh (44°57'35", 75°01'25"). Spawning was observed in the marsh and on the channel side of Nairne Island (44°57'40", 75°01'10") in areas with 2-4 ft of water, muck bottom, gently-sloping shoreline that flooded periodically, and scattered emergent, submergent, and floating marsh vegetation. Adults began moving to the shallow marshes in early May. Most spawning activity occurred at depths of 3 in. to 1 ft, and eggs were observed on aquatic plants and dead grass. Spawning began at 61-64°F and continued to 79-82°F. Spawning usually ceased sometime between late June and early August. Adults remained in the shallows throughout the summer; by late August they moved out to depths of 6 ft or more. Millions of newly hatched carp fry were observed in pools and depressions throughout the marsh; two weeks later, only a few could be found (Swee 1965; Swee and McCrimmon 1966).

RIVER CHUB

Cape Vincent (44°07'45", 76°20'00"). In 1979, adults were found inshore during spring and summer; they were presumed to be spawning (Haynes et al. 1979).

GOLDEN SHINER

In 1976, large catches of young-of-the-year golden shiners were made in the upper St. Lawrence River (Eckert and Hanlon 1977). Only one location was identified as a spawning ground.

Tibbits Creek (44°43'50", 75°26'05"). Schools of golden shiners spawned in the creek mouth over beds of vegetation in early June. Ripe males and females were collected, and eggs were found attached to vegetation and stones (Greeley and Greene 1931).

PUGNOSE SHINER

French Creek (44°14'00", 76°05'20"). In 1931, a male in breeding colors was collected at the creek mouth on July 11 (Raney 1969b).

Eel Bay (44°18'50", 76°02'30"). This species occurs rarely in the St. Lawrence River; in 1977, several adults in spawning condition were seined along shore in Eel Bay over a gravel and sand substrate with some weeds (Eckert, pers. comm. 1979; Eckert and Hanlon 1977).

BRIDLE SHINER

Cape Vincent (44°07'45", 76°20'00"). In 1979, adults were found inshore during spring and summer, probably for spawning (Haynes et al. 1979).

COMMON SHINER

Tibbits Creek (44°43'50", 75°26'05"). Common shiners spawned in early June at the mouth of the creek (Greeley and Greene 1931).

SPOTTAIL SHINER

Spottail shiners probably spawn over sand shoals in the St. Lawrence River in June or July (Dunning et al., undated).

Cape Vincent (44°07'45", 76°20'00"). In 1894, spottail shiners in spawning condition were found here in late June (Evermann and Kendall 1902a). In 1979, spottail shiners were found inshore in the harbor during spring and summer, probably for spawning (Haynes et al. 1979).

Morristown Point (44°36'00", 75°38'25"). Seine catches of adults increased at the east side of the point from late April to late May; this may have been a spawning concentration (Dunning et al., undated).

Ogdensburg (44°42'00", 75°29'30"). Many spawners and eggs were found in early June in a shallow sand area at the mouth of a small stream at the Ogdensburg Fish Hatchery (Greeley and Greene 1931).

Chimney Point (44°44'00", 75°26'50"). In 1978, many adults were seined in late May over sand and gravel on the west side of Chimney Point; this may have been a spawning concentration (Dunning et al., undated).

BLUNTNOSE MINNOW

Cape Vincent (44°07'45", 76°20'00"). In 1979, adults were found inshore in the harbor during spring and summer, probably for spawning (Haynes et al. 1979).

Tibbits Creek (44°43'50", 75°26'05"). Ripe or spawning adults were found at the creek mouth in early June (Greeley and Greene 1931).

LONGNOSE DACE

Cape Vincent (44°07'45", 76°20'00"). In 1979, adults were most abundant in July; this may have been a spawning concentration (Haynes et al. 1979).

WHITE SUCKER

White suckers enter tributaries of the St. Lawrence River to spawn in early spring after ice breakup (Greeley and Greene 1931; Toner 1943). In the 1930s, spawning runs had been limited by dams on tributaries such as the St. Regis and Grass rivers, but spawning still occurred in the lower sections of the rivers (Greeley and Greene 1931). Areas known to support spawning include:

French Creek (44°14'00", 76°05'20"). In 1975, some adults entered the creek in mid-April (Marean 1976).

Mullett Creek (44°16'35", 76°00'15"). In 1975, many adults entered the creek in mid- to late April, and one fry was found moving downstream in mid-June (Marean 1976; R. Werner, pers. comm. 1979).

Cranberry Creek East (44°21'10", 75°52'15"). In 1975, many adults entered the creek in late April (Marean 1976; R. Werner, pers. comm. 1979).

Chimney Bay (44°44'05", 75°26'10"). Young were collected in this area 3 mi downstream from Ogdensburg in mid-July (Bean 1903).

Tibbits Creek (44°43'50", 75°26'05"). In 1979, many adults were netted as they entered the creek in mid-April. White sucker larvae were 24% of the total catch of larvae in mid-May in Chimney Bay (44°44'05", 75°26'10"); it was believed that the migration of white sucker larvae out of the bay peaked before mid-May (Dunning 1979).

Grass River (44°59'15", 74°46'15") (Greeley and Greene 1931).

Raquette River (44°59'40", 74°41'15"). White suckers ran upstream to the dam at Raymondville. Young were found in mid-June in pools below the dam (Greeley 1934).

St. Regis River (45°00'10", 74°38'20") (Greeley and Greene 1931).

SILVER REDHORSE

Spawning runs of silver redhorses ascend almost every tributary of the upper St. Lawrence River (Eckert, pers. comm. 1979). This species spawns later than the shorthead redhorse (Greeley and Greene 1931).

Ogdensburg (44°42'00", 75°29'30"). Males in breeding condition were found in mid- to late June near Ogdensburg (Greeley and Greene 1931).

Raquette River (44°59'40", 74°41'15"). Adults ascend the Raquette River and its tributaries to the Raymondville Dam (Eckert, pers. comm. 1979; Greeley 1934). Young were found in the Squeak River, a tributary of the Raquette River (Greeley 1934).

SHORTHEAD REDHORSE

Spawning runs of shorthead redhorses ascend almost every tributary of the upper St. Lawrence River (Eckert, pers. comm. 1979). In the early 1930s, dams on the Grass and St. Regis rivers had curtailed spawning runs, but extensive spawning still occurred in the lower sections of these rivers (Greeley and Greene 1931).

Oswegatchie River (44°41'45", 75°29'55"). Males and females in spawning condition were observed on May 25. In early June, many adults were observed in shallow rapids (less than 2 ft deep); eggs were seen on the bottom among rocks when the water temperature was 67°F (Greeley and Bishop 1932).

Grass River (44°59'15", 74°46'15"). Adults were speared in the lower Grass River, and spawning runs were observed at Massena in early to mid-June (Greeley and Greene 1931).

Raquette River (44°59'40", 74°41'15"). Spawning runs ascended to the dam at Raymondville in the spring (Greeley 1934).

St. Regis River (45°00'10", 74°38'20"). Adults were speared in the river, and spawning was observed at Hogansburg (44°58'30", 74°40'00") (Greeley and Greene 1931).

GREATER REDHORSE

Spawning runs of greater redhorses probably enter the Raquette River (44°59'40", 74°41'15") and other tributaries (Eckert, pers. comm. 1979). In the early 1940s, this species spawned in areas of rapids in the St. Lawrence River in late May or early June (Toner 1943).

Thousand Island Area (44°20'00", 76°00'00"). Spawners moved into water 10 ft deep in the island and channel area near Ivy Lea (44°21'50", 76°00'35") and deposited eggs among boulders. Fry moved into shallow, fast water where they remained for their first summer of life (Toner 1943). In 1968, the spawning run of greater redhorses in the area closely followed that of the white suckers; greater redhorses were observed spawning at water temperatures of 62-66°F, during late June and early July (Jenkins 1970).

BROWN BULLHEAD

Brown bullheads move into shallow marshes in creek mouths and bays of the St. Lawrence River to spawn (Eckert and Hanlon 1977; Greeley and Bishop 1932; Greeley and Greene 1931).

Cape Vincent (44°07'45", 76°20'00"). In 1894, ripe adults were found at Cape Vincent in late June (Evermann and Kendall 1902a). In 1979, juveniles were found among rocks along shore; some spawning must have occurred in the harbor, although the habitat is not typical (Haynes et al. 1979).

French Creek (44°14'00", 76°05'20"). Spawning occurred in the lower creek (Greene et al. 1932). In 1974-75, some adults entered the marsh in April, and fry were collected here in June and July (Marean 1976).

Goose Bay (44°22'00", 75°51'15"). Spawning occurred in lower Cranberry Creek (45°21'15", 75°52'00") (Greene et al. 1932). Schools of young guarded by males were found nearshore in Goose Bay in 2-18 in. of water in late June (Greeley and Bishop 1932). In 1974-75, some adults entered Cranberry Creek Marsh in April, but only one fry was collected moving out of the marsh in June (Marean 1976).

Chippewa Creek (44°27'10", 75°45'30"). The lower 4 mi of the creek was a spawning area (Greene et al. 1932).

Morristown Bay (44°35'15", 75°39'10"). An egg mass guarded by an adult was found in early June at a water temperature of 62°F (Greeley and Bishop 1932).

Tibbits Creek (44°43'50", 75°26'05"). Brown bullheads spawned in the lagoon at the creek mouth in early June (Greeley and Greene 1931).

Coles Creek (44°53'45", 75°07'05"). A nest containing an egg mass and guarded by an adult was seen among roots and muck in less than 1 ft of water at the creek mouth in early June (Greeley and Greene 1931).

CHANNEL CATFISH

Eel Bay (44°18'50", 76°02'30"). Excavated nests and ripe males were found here in late June; newly hatched fry were found in early July. The nests were constructed in layers of submerged turf in 2-4 ft of water, 60-90 ft offshore (Greeley and Bishop 1932; Toner 1943).

French Creek (44°14'00", 76°05'20") and Cranberry Creek (44°21'15", 75°52'00"). Channel catfish from the river entered these creeks to spawn (Greene et al. 1932).

Chippewa Bay (44°26'50", 75°46'30") and Chippewa Creek (44°27'10", 75°45'30"). Many yolk-sac fry were collected in the bay southeast of the mouth of the creek in early July (Greeley and Bishop 1932). The lower 4 mi of Chippewa Creek provided spawning areas for fish entering from the river (Greene et al. 1932).

STONECAT

Gananoque (44°19'30", 76°09'50"). In early June 1935, one adult was found guarding an egg mass, which was attached to the underside of a flat rock in 1 ft of water (Toner 1937, 1943).

BURBOT

Burbot spawn in shallow water 1-4 ft deep, over sand or gravel. Spawning occurs under the ice, usually from January to March, when water temperatures are 33-35°F (NALCO 1978).

Morristown (44°35'00", 75°39'00"). In 1979, a few burbot larvae were caught in the harbor in mid-May (Dunning 1979).

Chimney Bay (44°44'05", 75°26'10"). In 1978, one burbot egg was collected inshore east of Chimney Point in late April (NALCO 1978). In 1979, a few larvae were collected in mid-May in the bay (Dunning 1979).

Brandy Brook (44°52'50", 75°09'45"). In 1978, one prolarva was collected in the channel off the mouth of the brook in mid-May (NALCO 1978).

BANDED KILLIFISH

Cape Vincent (44°07'45", 76°20'00"). In 1894, ripe adults were found at Cape Vincent in late June (Evermann and Kendall 1902a).

ROCK BASS

Rock bass spawn in the St. Lawrence River in 3-15 ft of water over gravel shoals and rocky ledges during June and July. Rock bass and smallmouth bass spawn in the same areas, but the rock bass spawns later than the smallmouth bass, when the water temperature is a few degrees higher (Schneider and Panek, pers. comm. 1979). Rock bass also enter creek mouths to spawn (Greeley and Greene 1931).

Cape Vincent (44°07'45", 76°20'00"). Rock bass is one of the species most commonly observed in spawning condition in the harbor. Spawning occurs in June and July, and eggs are often deposited on clam shells (Haynes et al. 1979).

Millen Bay (44°10'15", 76°14'45"). A nest containing eggs was observed in late June (Greeley and Bishop 1932).

French Creek (44°14'00", 76°05'20"). In 1975, adults entered the marsh in mid-April, and a few fry were found in early June (Marean 1976).

Morristown Bay (44°35'15", 75°39'10"). Spawning was observed, and nests containing eggs were seen in nearshore areas during June at water temperatures of 70-72°F (Greeley and Bishop 1932).

Tibbits Creek (44°43'50", 75°26'05"). A male was seen guarding a nest containing eggs in the lagoon at the creek mouth in early June (Greeley and Greene 1931).

PUMPKINSEED

The shallow embayments and creek mouths of the St. Lawrence River are used as spawning and nursery areas by the pumpkinseed (Eckert and Panek, pers. comm. 1979). Pumpkinseeds are the most abundant fish entering the marshes in the spring (Marean 1976). In 1976, pumpkinseed larvae were commonly found in the shallow water zones of the upper river; peak abundance occurred in mid-July (Werner 1977). Pumpkinseed larvae were only 4% of the total, but were one of the more abundant larvae (FWS 1979d; Werner 1977).

Cape Vincent (44°07'45", 76°20'00"). In 1894, adults were found in spawning condition here in late June (Evermann and Kendall 1902a).

Millen Bay (44°10'15", 76°14'45"). In 1974-75, adults entered the marsh in mid-April to early May; one fry was found there in late July (Marean 1976).

French Creek (44°14'00", 76°05'20"). This is a heavily used spawning area (R. Werner, pers. comm. 1979). In 1974-75, many adults entered the marsh in late March to April, and a few fry were found in early July (Marean 1976). Historically, a large school of adults, which included females that appeared to be "distended with eggs", entered the creek mouth in mid-June (Greeley and Bishop 1932).

Cranberry Creek (44°21'15", 75°52'00"). In 1974-75, adults entered the marsh in late April, and a few fry were found there in early July (Marean 1976).

Tibbits Creek (44°43'50", 75°26'05"). Spawning was observed at the creek mouth from mid-June to early July (Greeley and Greene 1931).

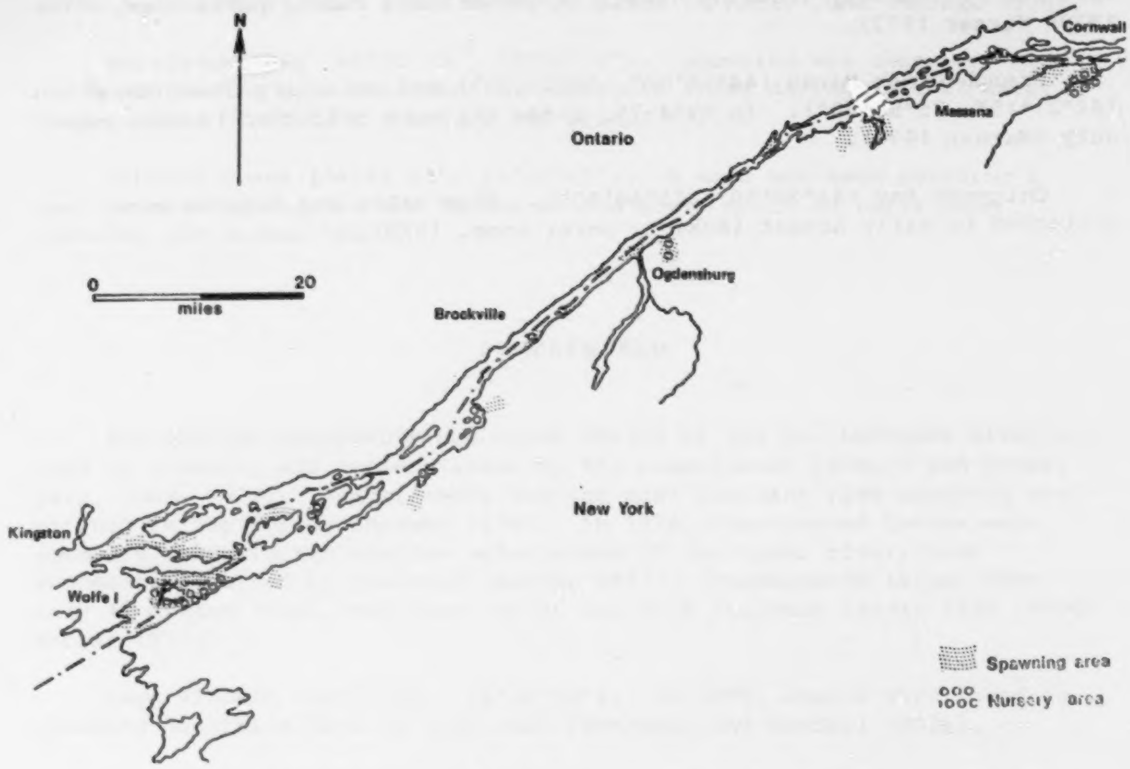
BLUEGILL

The shallow areas throughout the St. Lawrence River are used as spawning and nursery areas by bluegills (Eckert and Panek, pers. comm. 1979; Werner 1977).

French Creek Marsh (44°14'00", 76°05'20") and Cranberry Creek Marsh (44°21'15", 75°52'00"). In 1974-75, a few fry were collected in June and July (Marean 1976).

Chippewa Bay (44°26'50", 75°46'30"). Ripe males and females were collected in early August (Eckert, pers. comm. 1979).

SMALLMOUTH BASS


N
0
20
miles
Cornwall
Massena
Ontario
Ogdensburg
Brockville
New York
Kingston
Wolfe I
Spawning area
Nursery area

In the upper St. Lawrence River, smallmouth bass move inshore to depths of 3-15 ft to spawn over gravel shoals and rock ledges (Eckert and Hanlon 1977; Greeley and Greene 1931; Schneider and Panek, pers. comm. 1979). Large spawning runs enter tributaries; most spawning in tributaries occurs near the mouth (Greeley and Greene 1931). Historically, the spawning period in the upper river extended from mid-May to July (Rathbun and Wakeham 1897). In the tributaries, spawning occurs during late May to early June; whereas in the colder St. Lawrence River river waters, spawning is later and can continue into July (Greeley, undated; Greeley and Greene 1931; Ont. Game Fish 1912; Stone et al. 1954). Ripe females were collected in the river as late as mid-August (Panek, pers. comm. 1980). Young-of-the-year (YOY) smallmouth bass are found in the littoral zone (Eckert and Hanlon 1977).

Wolfe Island (44°10'00", 76°25'00"). Several spawning areas have been identified here.

Hinckley Point (44°08'30", 76°21'25"). South shore at the base of the point (Whillans, pers. comm. 1979) and around the point (Environ. Can. 1977b).

Hinckley Flats Shoal (44°09'05", 76°20'45"). Button Bay (44°08'55", 76°22'00"). Along the north shore. Bayfield Island (44°11'35", 76°19'45")--Banford Point (44°12'25", 76°14'20"). Along the south shore of Bayfield Island and eastward along shore to about 2 mi E of Banford Point (Whillans, pers. comm. 1979).

Beauvais Point (44°14'00", 76°10'50"). The shoreline around the point. Quebec Head (44°14'20", 76°11'15"), Brakey Bay (44°13'50", 76°13'35"), Dignam Point (44°13'50", 76°13'55), and Rattray Point (44°14'05", 76°14'25")--Irvine Bay (44°13'40", 76°16'30") (Environ. Can. 1977b).

Holliday Point (44°14'00", 76°16'55") and Oak Point (44°14'15", 76°20'05") (Environ. Can. 1977b; Whillans, pers. comm. 1979).

Brophy Point (44°14'00", 76°23'30") and Knapp Point (44°13'55", 76°23'55") (Environ. Can. 1977b).

Browns Bay (44°13'15", 76°24'10"). Around the shoreline (Environ. Can. 1977b; Whillans, pers. comm. 1979).

Dawson Point (44°12'55", 76°25'30") (Environ. Can. 1977b).

Ferguson Point (44°12'20", 76°26'45"). North shore (Whillans, pers. comm. 1979).

Milton Island (44°14'40", 76°23'55") and The Spectacles (44°14'35", 76°23'15") (Whillans, pers. comm. 1979).

Cassidys Point (44°15'30", 76°20'50"). Along the north shore. Quinn's Bay (44°15'35", 76°16'35") (Whillans, pers. comm. 1979).

Cape Vincent (44°07'45", 76°20'00"). In 1979, smallmouth bass was one of the species most commonly observed in spawning condition in the harbor; spawning occurred throughout the area in June and July (Haynes et al. 1979).

Carleton Island (44°10'45", 76°17'30"). A local population resides in the area (Stone 1951). Young-of-the-year were collected in August and September at depths as great as 15-20 ft (Stone et al. 1951, 1954).

Millen Bay (44°10'15", 76°14'45"). In 1931, nests and many fry were found here in late June (Greeley and Bishop 1932). In 1948-49, nests containing eggs and many fry were found along the protected west shore on gravel in less than 3 ft of water during June 15-30 when the water temperature was 63-70°F. Fry were first seen on June 23 (Stone et al. 1951, 1954).

Dodge Bay (44°10'55", 76°14'00"). In 1948-49, YOY were collected in August (Stone et al. 1951, 1954).

Linda Island (44°12'10", 76°12'25"). A local population resides in the area (Stone et al. 1951). In 1948-49, YOY were collected in August and September at depths as great as 15-20 ft (Stone et al. 1951, 1954).

Cedar Point State Park (44°12'20", 76°11'55") and Beadle Bay (location unknown). Nests were seen here in June (Stone et al. 1951, 1954).

French Creek (44°14'00", 76°05'20"). Spawning occurred in the lower section of the creek (Greene et al. 1932).

Grindstone Island (44°17'00", 76°07'00"). In 1948-49, nests were observed in June along the north shore (Stone et al. 1951, 1954).

Eel Bay (44°18'50", 76°02'30"). A local population exists in the bay (SLEOC 1978; Stone et al. 1951, 1954). In 1948-49, heavy spawning occurred in the bay during the first 2 weeks of June; fry were observed in late June (Stone et al. 1951, 1954).

Point Vivian Marsh (44°19'00", 75°57'05"). This is a potential spawning area (Werner and Ford 1972).

Goose Bay (44°22'00", 75°51'15"). In 1931, many shallow rocky areas provided good spawning habitat, and many fry were found in the bay in late June (Greeley and Bishop 1932). Spawning also occurred in the lower section of Cranberry Creek (44°21'10", 75°52'15") (Greene et al. 1932).

Chippewa Bay (44°26'50", 75°46'30"). A spawning run enters the bay (Dunning et al., undated). Spawning occurred in the lower 4 mi of Chippewa Creek (44°27'10", 75°45'30") (Greene et al. 1932). In 1931, spent adults and fry were found in the bay in mid-June (Greeley and Bishop 1932); in 1978, YOY were collected there in August (Dunning et al., undated).

Morristown (44°35'20", 75°39'00"). A spawning run occurs here (Dunning et al., undated). In 1931, nests, eggs, and many fry were observed during June, especially along the west shore of Morristown Bay. Nests were in 1-2 ft of water among rocks, gravel, and sticks (Greeley and Bishop 1932).

Brooks Point (44°36'55", 75°36'35"). In 1931, nests, eggs, and fry were seen near here at the mouth of an unnamed tributary on gravel in 11 inches of water in mid-June at a water temperature of 77°F (Greeley and Bishop 1932).

Ogdensburg (44°42'00", 75°29'30"). In 1930, spent males and females were collected here in June (Greeley and Greene 1931).

Tibbits Creek (44°43'50", 75°26'05"). A spawning run enters the creek (Dunning et al., undated). In 1930, ripe or spawning adults and a nest were found at the creek mouth in early June; spent males and females were found here in mid-June, and fry were present on July 1 (Greeley and Greene 1931).

Iroquois (44°51'00", 75°18'30"). Spawning beds were observed here (Ont. Game Fish 1909, 1912).

Little Sucker Brook (44°52'00", 75°11'05"). In 1930, spent males and females were found here in mid-June (Greeley and Greene 1931).

Brandy Brook (44°52'50", 75°09'45"). In 1930, spent males were found here in mid-June (Greeley and Greene 1931).

Coles Creek (44°53'45", 75°07'05"). A spawning run enters the creek (Dunning et al., undated; Webster et al. 1959).

Little Sny Channel (44°58'20", 74°56'40"). In 1933, some ripe and spent adults were found here in mid-June, and young fry were found along shore in early July (Greeley 1934).

Grass River (44°59'15", 74°46'15"). In 1930, spent males and females were found here in mid-June (Greeley and Greene 1931).

Raquette River (44°59'40", 74°41'15"). In 1933, large runs moved upstream to the Raymondville dam. Pollution prevented spawning in the Raquette River proper, but the presence of nests with eggs and many fry indicated that successful spawning occurred in almost all of the river's lower tributaries in May and early June. Young were found in mid-June in pools below the dam (Greeley 1934).

LARGEMOUTH BASS

The shallow embayments and marshy littoral areas throughout the St. Lawrence River are spawning and nursery grounds for largemouth bass (Eckert and Hanlon 1977; Panek, pers. comm. 1979).

Navy Bay (44°14'00", 76°28'00"). Spawning occurs at the head of the bay (Whillans, pers. comm. 1979).

Madoma Marsh (44°15'45", 76°22'45") (Whillans, pers. comm. 1979).

Wolfe Island (44°10'00", 76°25'00"). Spawning occurs at the following locations.

Button Bay (44°08'55", 76°22'00"). Head of bay. McGregor Bay (44°12'15", 76°19'10"). In the bay and around Macandie Point (44°12'00", 76°19'40"). Beauvais Point (44°14'00", 76°10'50"). Along the shore about 2 mi W of the point. Irvine Bay (44°13'40", 76°16'30"). Head of bay (Whillans, pers. comm. 1979).

French Creek (44°14'00", 76°05'20"). In 1931, spawning occurred in the lower section of the creek (Greene et al. 1932). In 1974-75, a few adults moved into the marsh in April; a large number of fry moved out of a tributary to the creek in June (Marean 1976; R. Werner, pers. comm. 1979).

Eel Bay (44°18'50", 76°02'30"). In 1931, a spent female and many fry were seen in the shallows of the bay during late June when the water temperature was 77°F (Greeley and Bishop 1932).

Cranberry Creek (44°21'15", 75°52'00"). In 1931, spawning occurred in the lower section of the creek (Greene et al. 1932). In 1974-75, a few adults entered the marsh in late April, and large numbers of fry were collected there in June (Marean 1976; R. Werner, pers. comm. 1979).

Chippewa Creek (44°27'10", 75°45'30"). In 1931, spawning occurred in the lower 4 mi of the creek (Greene et al. 1932). In 1978, large numbers of fry were found at the mouth of the creek among dense vegetation over a mud bottom in mid-July (Dunning et al., undated).

Ogdensburg (44°42'00", 75°29'30"). In 1930, young largemouth bass were common among weed beds in the area in early September (Greeley and Greene 1931).

BLACK CRAPPIE

Spawning runs of black crappies enter bays, creek mouths, and lower sections of streams in the spring (Eckert and Hanlon 1977; Greene et al. 1932).

French Creek (44°14'00", 76°05'20"). In 1931, spawning occurred in the lower section of the creek (Greene et al. 1932). In 1974-75, adults entered the marsh in mid- to late April, and a few fry were found there in June (Marean 1976).

Alexandria Bay (44°20'05", 75°55'20"). Ripe fish were collected here in shallow water in late April to May (Eckert and Panek, pers. comm. 1979).

Cranberry Creek (44°21'15", 75°52'00"). In 1931, spawning occurred in the lower section of the creek (Greene et al. 1932). In 1974-75, adults entered the marsh in late April, and a few fry were found there in early July (Marean 1976).

Chippewa Bay (44°26'50", 75°46'30"). In 1931, spawning occurred in the lower 4 mi of Chippewa Creek (44°27'10", 75°45'30") (Greene et al. 1932). Ripe fish were collected in the bay in shallow water in late April to May (Eckert and Panek, pers. comm. 1979).

IOWA DARTER

Iowa darters are not commonly seen in the St. Lawrence River except when they move inshore in the spring to spawn (Eckert, pers. comm. 1979; Eckert and Hanlon 1977). In 1930, this species was uncommon except in creek mouths (Greeley and Greene 1931).

Tibbits Creek (44°43'50", 75°26'05"). In 1930, males and females in spawning condition were found at the creek mouth in early June (Greeley and Greene 1931).

Waddington (44°52'00", 75°12'10"). In 1976, a few adults in spawning condition were captured near shore in late May (Eckert and Hanlon 1977).

Massena (44°56'00", 74°53'00"). Adults move inshore to spawn in early summer (Eckert, pers. comm. 1979).

JOHNNY DARTER

Cape Vincent (44°07'45", 76°20'00"). In 1979, gravid adults were observed here in the spring. Spawning occurs under rocks along shore (Haynes et al. 1979).

Chimney Bay (44°44'05", 75°26'10"). In 1979, a few larvae were collected in 49 ft of water in mid-May (Dunning 1979).

YELLOW PERCH

Yellow perch are abundant in the St. Lawrence River; they spawn in shallow, weedy areas (Eckert and Schneider, pers. comm. 1979). In 1976, yellow perch larvae were one of the more abundant larvae in the upper river (FWS 1979d; Werner 1977); they were most common in water less than 12 ft deep from early to mid-July (Werner 1977).

Cape Vincent (44°07'45", 76°20'00"). A resident population of yellow perch spawns in the harbor area. In 1979, juveniles were observed here in the nearshore waters (Haynes et al. 1979).

Wolfe Island (44°10'00", 76°25'00"). Shoreline areas provide suitable spawning habitat for yellow perch (Environ. Can. 1977b); spawning occurs in several areas.

> Button Bay (44°08'55", 76°22'00"). Embayments on the north shore. Bayfield Island (44°11'35", 76°19'45"). Along shore, except on the south side. Lewis Point (44°12'25", 76°16'00"). Along shore west of the point. Chub Point (44°14'00", 76°20'35") (Whillans, pers. comm. 1979).

Quinns Bay (44°15'35", 76°16'35") (Whillans, pers. comm. 1979).

Chippewa Bay (44°26'50", 75°46'30"). Spawning occurs near rooted vegetation in shallow weedy areas during mid-April to early May when water temperatures are 48-54°F. In 1978, eggs and prolarvae were collected in May, and young-of-the-year were collected throughout the summer; they became more abundant as the summer progressed (Dunning et al., undated, 1978; NALCO 1978).

Morristown Harbor (44°35'25", 75°39'05") and Morristown Point (44°36'00", 75°38'25"). In 1978-79, large numbers of ripe and gravid adults were seen in late April, and large numbers of larvae were observed in mid-May. Yellow perch may spawn in areas downstream from the point during years when conditions are favorable (Dunning 1979; Dunning et al., undated, 1978).

St. Lawrence State Park (44°38'15", 75°34'55"). This area may be used for spawning during years when conditions are favorable (Dunning et al., undated).

Ogdensburg (44°42'00", 75°29'30"). In 1978, many adults were collected in littoral areas in late April and early May (Dunning et al. 1978).

Tibbits Creek (44°43'50", 75°26'05"). In 1978-79, large numbers of ripe and gravid adults were seen here in late April, and large numbers of larvae were observed here in mid-May (Dunning 1979; Dunning et al., undated).

Chimney Bay (44°44'05", 75°26'10"). In 1902, young about 1.5 in. long were found in this area, 3 mi downstream from Ogdensburg (Bean 1903). In 1979, large numbers of ripe and gravid adults and many larvae were observed in the bay (Dunning 1979).

Coles Creek (44°53'45", 75°07'05"). In 1978, many adults were collected in littoral areas at the mouth of the creek in late April and early May (Dunning et al. 1978).

LOGPERCH

Chippewa Bay (44°26'50", 75°46'30"). In 1978, adults were collected in seines in July and August on sandy shallows along the north shore of Allens Point (44°27'15", 75°46'05"). The collecting sites were typical spawning habitat, and spawning may occur in the area (Dunning et al., undated).

Tibbits Creek (44°43'50", 75°26'05"). In 1930, many adults, including several ripe males, were found in the lower creek in early June (Greeley and Greene 1931).

WALLEYE

Walleyes entered St. Lawrence River tributaries and moved short distances upstream to spawn (Greeley and Greene 1931). The population in the upper river between Ogdensburg (44°42'00", 75°29'30") and Massena (44°56'00", 74°53'00") declined dramatically between 1960 and 1970 after construction of the Moses-Saunders Power Dam (45°00'25", 74°47'45") eliminated upstream spawning areas. Most walleyes in the river are now found below the dam (Eckert and Hanlon 1977; Int. Great Lakes Levels Board 1973; SLEOC 1978).

Chippewa Creek (44°27'10", 75°45'30"). A juvenile walleye was found east of Brier Hill, about 12 mi upstream (Werner and Ford 1972); walleyes may enter the creek to spawn (R. Werner, pers. comm. 1979).

Oswegatchie River (44°41'45", 75°29'55"). A spawning run still enters the river (Eckert and Hanlon 1977), however, successful spawning probably ended here when the mouth was flooded by dam construction on the St. Lawrence River (Geis and Hyduke 1978).

Sucker Brook (44°52'10", 75°11'45") and Little Sucker Brook (44°52'00", 75°11'05"). In 1930, young walleyes were found in these streams (Greeley and Greene 1931).

Brandy Brook (44°52'50", 75°09'45"). Historically, this was one of the most important spawning areas (Dunning et al., undated; Greeley and Greene 1931). Young walleyes were found in the brook during June (Greeley and Greene 1931). Spawning runs still occur (Eckert and Hanlon 1977).

Long Sault Rapids (approximately 44°59'35", 74°53'40"). This was an important spawning site prior to its flooding by the construction of the Moses-Saunders Power Dam (45°00'30", 74°47'30") (Int. Great Lakes Levels Board 1973).

Grass River (44°59'15", 74°46'15") and St. Regis River (45°00'10", 74°38'20"). In 1930, young walleyes were found in the lower river (Greeley and Greene 1931).

SLIMY SCULPIN

The inshore waters and tributary streams of the St. Lawrence River are spawning and nursery habitat for this species (LMS 1977).

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This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area.
The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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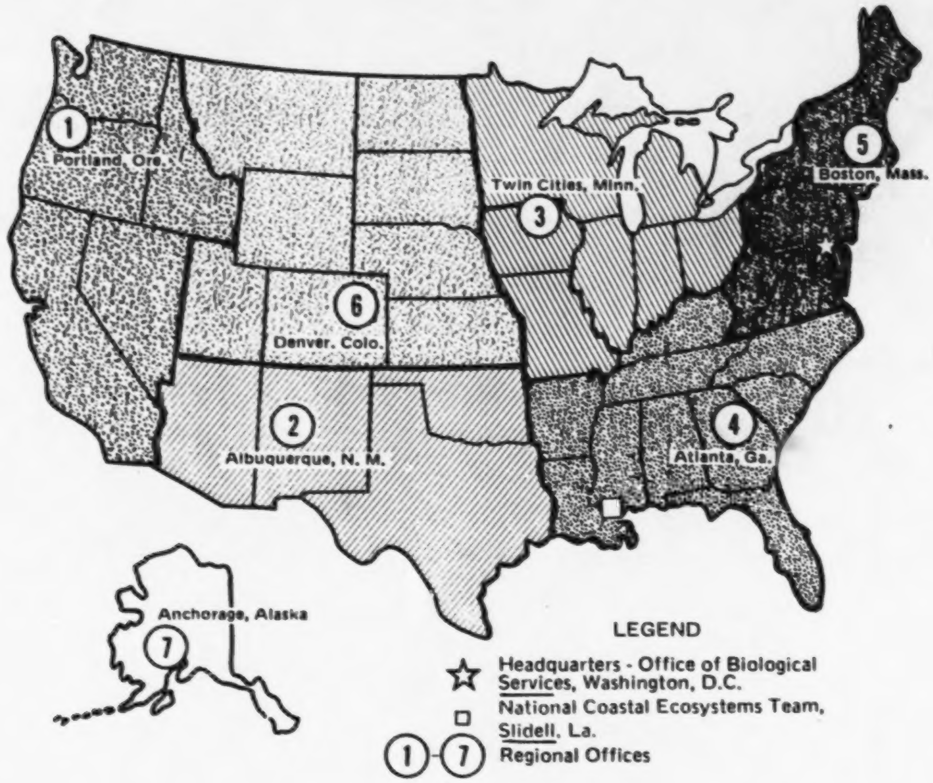

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Volume XIII-Species Reproduction Characteristics

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ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME XIII
Reproductive Characteristics of Great Lakes Fishes

by

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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INTRODUCTION

This volume presents concise descriptions of the reproductive characteristics and related spawning and nursery habitat requirements of each of the species included in Volumes I-XII of the atlas. These descriptions were compiled mainly from the information for Great Lakes populations that is presented in Volumes I-XII. When we needed additional information to complete the descriptions in this volume, we included information for non-Great Lakes populations in the Province of Ontario and the eight states bordering the Great Lakes; in some instances we also included information for populations outside the Great Lakes region. When we presented information for non-Great Lakes populations, we identified by footnote the geographic location of the population from which the information was obtained.

Information extracted from Volumes I-XII and presented in this volume is not specifically referenced in this volume. References listed in this volume represent only the information that does not appear in Volumes I-XII. Complete citations for the referenced information in Volumes I-XIII appear in Volume XIV.

SEA LAMPREY

MIGRATION OF ADULTS

Prespawning: Congregate in bays and river mouths in late winter; ascend streams, often more than 100 mi, beginning as early as late-January at 40°F; early migrants may be in streams several weeks prior to spawning.

Postspawning: Drift away from spawning grounds and die; males may remain on nests for up to 5 days after spawning.

SPAWNING

Season: March-September, usually May-July, at 50-82°F; peaks in late May-early June at 58-60°F.

Site: Clean, moderately swift water, with velocity of 2-5 fps, often just above rapids or riffles in streams.

Substrate: Eggs are deposited in nests excavated in sand, gravel, and rocks; sometimes also in nests excavated in substrate consisting mainly of clam shells or lumps of clay.

Water Depth: To 12 ft; usually to 3 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate in nest under a layer of sand and gravel.

Duration: Eggs hatch in 1-3 weeks; 14 days at 61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in nest 1-3 weeks; ammocoetes are carried downstream from nest to areas of quiet water and burrow into stream bed where they remain for 3-17 years; ammocoetes are also found along lake shores, in bays, and on alluvial fans as far as 2 mi, but usually less than 1/4 mi, from stream mouths.

Substrate: Gravel for prolarvae; soft substrate of detritus, mud, sand, or silt for ammocoetes; also found under objects on hard substrate.

Water Depth: To 75 ft.

REFERENCES

Applegate 1949, 1951b, 1961; Applegate and Brynildson 1952; Applegate and Moffett 1955; Bams 1959; Bean 1902, 1903; Brasch 1950; Eddy and Underhill 1974; Embody 1922; Fish. Res. Board Can. 1955; Fisherman 1952; Gage 1893, 1928; Greeley 1928; Guard 1953; Hubbs and Lagler 1958; Kennedy 1957; Lagler 1948; Lamsa 1961, 1963b; Lawrie 1955a; Lennon 1955; Loftus 1950; Manion 1968, 1972; Manion and Hansen 1980; Manion and Smith 1978; Moffett 1966b; Reed and Wright 1909; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith, B., and Elliott 1953; Smith, S. 1978c; Stauffer 1962; Surface 1897; Westerman 1946; Wigley 1953, 1959.

LAKE STURGEON

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral waters and tributaries; enter tributaries in spring, usually after ice-out, but sometimes before ice-out; long upstream migrations recorded (125 mi in Wolf River, Wisconsin).

Postspawning: Leave tributaries after spawning.

SPAWNING

Season: April-July at 48-70°F, but usually May and June at 57-60°F; spawning may be inhibited at 70°F; duration of peak spawning usually 3-4 days.

Site: Rapids or other fast-water areas of streams or wave-swept lake shoals or ledges along shore; historically spawned in almost all Great Lakes tributaries.

Substrate: Eggs are broadcast over hard bottom, including rock, gravel, boulders, shale, hard clay and sand, and coal cinders.

Water depth: 1-30 ft; 3-4 ft is preferred depth range in lakes.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate at spawning site.

Duration: Eggs hatch in 5-8 days at 60-57°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae drift with current; fry inhabit bays and eddies where current is not too swift.

Substrate: Exposed rock and rubble or mud.

Water Depth: Shallow; no detailed information.

REFERENCES

Becker 1976; Calhoun and Coon 1941; Coker 1930; Crossman 1976; Eddy and Underhill 1974; Evermann and Latimer 1910; Fogle 1975; Harkness 1923; Hubbs and Lagler 1958; Lagler 1948; MacKay 1959b, 1969; Meehan 1900; Mich. Cons. 1946; ODNR, undated; Price 1960, 1961; Priegel 1960, 1961; Priegel and Wirth 1971; Roussow 1957; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith 1972; Smith and Moe 1944; Stone 1900, 1901; Surber 1920; Van Oosten 1956; Williams 1951.

SPOTTED GAR

MIGRATION OF ADULTS

Prespawning: Congregate on spawning grounds in marshes.

Postspawning: Remain on spawning grounds for extended period.

SPAWNING

Season: May and June at 70-78°F; usually completed by early June.

Site: Quiet marshes and grassy sloughs.

Substrate: Eggs are deposited over vegetation, mud, and silt.

Water Depth: Usually 3 ft or less.

INCUBATION AND HATCHING

Site: Eggs adhere to plants and debris at spawning site.

Duration: Eggs hatch in 6-8 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain attached by cement gland to submerged objects for 9-10 days; fry remain in vegetated spawning areas[1/]; young-of-the-year (YOY), 0.8-2.5 in. long, inhabit shallow littoral water.

Substrate: Vegetation, mud, silt, sand.

Water Depth: 2-3 ft; YOY are often seen just beneath the surface.

REFERENCES

Echelle 1967[1/]; Echelle and Riggs 1967[1/]; Eddy and Underhill 1974; Garman 1889; Mich. Cons. 1932b; ODNR, undated; Richardson 1913; Scott 1967; Slastenenko 1958.

[1/] Oklahoma and Texas

LONGNOSE GAR

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral areas and tributaries beginning in April; historically entered tributaries at the same time as lake sturgeon.

Postspawning: Lake spawners move offshore; tributary spawners return to lake[1] or move downstream to larger river pools after spawning[2].

SPAWNING

Season: May and June at 66-84°F; may peak at 66°F.

Site: Nearshore weed beds of lakes; open sloughs and backwaters of tributaries.

Substrate: Eggs are scattered over aquatic plants, sand, silt, gravel, rock, mud, decaying vegetation, or deposited in a loosely constructed nest.

Water depth: 6 in. - 2 ft; usually less than 1 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation, roots, debris, or stones at spawning site.

Duration: Eggs hatch in 5-9 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae attach to objects by means of adhesive disk; larvae begin to swim when about 3 weeks old. Young-of-the year (YOY) remain in weed beds along shore throughout the summer.

Substrate: Vegetation, mud, silt, sand.

Water Depth: No detailed information; YOY move from shallows to deeper water as they grow; they are often seen just beneath the surface, above submerged vegetation.

REFERENCES

Agassiz 1878; Bean 1903; Cady 1945[1]; Cahn 1927; Coker 1930; Dean 1895; Eddy and Underhill 1974; Evermann and Clark 1920; Eycleshymer 1903; Faber 1963; Forbes and Richardson 1920; Frisby 1942; Hay 1894; Hubbs and Lagler 1958; Lagler 1948; MacKay 1957e, 1969; Mark 1890; Meek and Hildebrand 1910; Mich. Cons. 1932b; Netsch and Witt 1962[2]; ODNR, undated; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Surber 1920; Williamson 1951; Wright 1879.

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[1] Tennessee

[2] Missouri

BOWFIN

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral waters or tributaries.

Postspawning: Male remains on spawning ground for several weeks to guard nest and fry before returning to deeper water.

SPAWNING

Season: Late March-late July, but usually April-June; spawning peaks at 61-66°F and usually ceases at 68°F, but has been observed at 79°F.

Site: Protected, weedy shallows, embayments, marshes and tributary mouths; also in streams and flooded bottomlands.

Substrate: Eggs are scattered over bottom of large nest scooped out in cleared area or under a log or bush on soft bottom, including submerged vegetation, mud, silt, sand, muck, and organic debris; occasionally nest built on gravel.

Water Depth: 8 in. - 6 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to exposed roots, leaves, stems, or gravel in the nest.

Duration: Eggs hatch in 4-14 days, usually 8-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain attached to rootlets and debris in the nest for about 9 days; after leaving nest, fry remain in weedy shallows and are seen in open water accompanied by male; older young-of-the-year usually seek protection under bushes or vegetation.

Substrate: Soft bottom, as described for spawning site.

Water Depth: Fry up to about 1.5 in. long are found in 1-1/2 to 2 ft of water; those 2-4 in. long are found in water as shallow as 6 in.

REFERENCES

Allen 1914; Bean 1903; Cahn 1927; Coker 1930; Dean 1896, 1899; Eaton 1928; Eddy and Underhill 1974; Evermann and Clark 1920; Forbes and Richardson 1920; Garman 1899; Goode 1884; Greeley 1928; Hubbs and Lagler 1958; Kramer and Smith 1960; Lagler 1948; MacKay 1958b, 1969; Meek and Hildebrand 1910; Mich. Cons. 1932b; Pearse 1918a; Price and Kelly 1976; Raphael and Jaworski 1979; Reighard 1900a,b, 1902, 1903; Richardson 1913a; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Surber 1920; Whitman and Eycleshymer 1897.

AMERICAN EEL

MIGRATION OF ADULTS

Prespawning: Only catadromous resident of the Great Lakes; adults migrate from fresh water to spawning grounds in the Atlantic Ocean in July-January; in the Great Lakes migration usually occurs in September and October.

Postspawning: None; both sexes die after spawning.

SPAWNING

Season: Probably late winter to summer at about 60°F.

Site: Sargasso Sea, northeast and east of the West Indies, approximately between latitudes 20° and 30° and longitudes 60° and 78°.

Substrate: No information; eggs broadcast in open water.

Water Depth: Greater than 3,000 ft.

INCUBATION AND HATCHING

Site: Eggs incubate at surface of open sea.

Duration: Eggs hatch in 2 days or less.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae (leptocephali) drift in open ocean; after about one year, they reach the Atlantic coast and transform to elvers, which ascend rivers along the east coast of the U.S and Canada usually in April-June.

Substrate: No information.

Water Depth: Leptocephali drift from deep oceanic spawning ground to littoral coastal areas; after reaching lakes, elvers are found in littoral zone in water 6-15 ft deep.

REFERENCES

Adams and Hankinson 1916, 1928; Balon 1975; Bean 1902, 1913; Breder 1962; Eaton 1928; Eigenmann 1902; Gill 1908; Goode 1881; Greeley 1929; Lauer et al. 1974; Nash 1913; Radforth 1944; Raney 1959; Schmidt 1925, 1928; Smith 1913; Smith and Saunders 1955; Wickliff 1957.

ALEWIFE

MIGRATION OF ADULTS

Prespawning: Move from overwintering areas in deep water to spawning grounds in littoral waters and tributaries; movement occurs in March-July, usually April-June, beginning at 43-50°F.

Postspawning: Disperse offshore to deep water in late July or August.

SPAWNING

Season: March-September at 44-72°F, but usually May-August at 55-70°F; peak spawning occurs in June and July; spawning occurs earlier in tributaries than along lake shores.

Site: Shorelines, tributaries, and protected nearshore areas, including beaches, river mouths, marshes, canals, bays, and harbors, especially near breakwalls.

Substrate: Eggs are broadcast over a wide variety of substrate, including sand, clay, mud, silt, gravel, rock, rubble, detritus, and submersed vegetation.

Water Depth: 1-60 ft; usually less than 30 ft.

INCUBATION AND HATCHING

Site: Initially eggs adhere to plants, stones, and debris; but subsequently eggs become demersal.

Duration: Eggs hatch in 2-6 days at 72-60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in warm water in tributaries and in nearshore areas; move offshore when nearshore waters cool in September and October.

Substrate: Varied, including sand, clay, silt, gravel, scattered rock, and submerged vegetation.

Water Depth: To 70 ft but are usually most abundant within 6-10 ft of the surface in water less than 30 ft deep.

REFERENCES

Allen 1914; Bean 1902, 1903; Eddy and Underhill 1974; Green 1880; Odell 1934; Price and Kelly 1976; Rothschild 1966; Scott and Crossman 1973; Smith 1969; USDI 1969b.

GIZZARD SHAD

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral waters and tributaries in April and May, when water temperature increases to 59°F.

Postspawning: Return to lake after spawning, usually in August.

SPAWNING

Season: Early May-late August at 60-77°F; peak spawning occurs in late May-late June at water temperatures above 67°F; also reported to spawn on falling temperatures.

Site: Quiet, protected areas with some current, including harbors, bays, marshes, sloughs, river mouths, beaches, backwaters, and low gradient streams and ditches.

Substrate: Eggs are broadcast over mud, sand, and gravel with detritus and emergent and submergent vegetation; also over rock; eggs sink slowly.

Water Depth: 6 in. - 16 ft; usually 1-4 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to any submersed object, including plants and rocks, at spawning site.

Duration: Eggs hatch in 2-4 days at 80-62°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are buoyant, move with current, and concentrate in the lower reaches of rivers and streams, around breakwalls in harbors, and in bays and along beaches; young-of-the-year (YOY) remain in nearshore areas throughout summer.

Substrate: Mud and muck with submerged vegetation; occasionally sand and rock with no vegetation.

Water Depth: To 10 ft, but usually less than 4 ft; YOY swim just below surface.

REFERENCES

Balon 1975; Eddy and Underhill 1974; Garman 1889; Hartley 1975; Kirsch 1895; Miller 1960; Momot et al. 1977; Storck et al. 1978; Trautman 1957; Tucker 1968; Warner 1940; Wickliff 1936, 1957.

MOONEYE

MIGRATION OF ADULTS

Prespawning: Move into tributaries to spawn.

Postspawning: No information.

SPAWNING

Season: April-early July at approximately 67°F.

Site: Fast-water areas of large, clear streams.

Substrate: Eggs are broadcast over rock.

Water Depth: Usually less than 2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate among rocks at spawning site.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are planktonic and are carried from spawning ground by current.

Substrate: No information.

Water Depth: No information.

REFERENCES

Crossman 1976; Eddy and Underhill 1974; Faber 1963; Gammon 1976; Trautman 1957.

LONGJAW CISCO[1]

MIGRATION OF ADULTS

Prespawning: Move to shallower water to spawn; reported to enter bays and tributaries.

Postspawning: No information.

SPAWNING

Season: November, but sometimes beginning in October.

Site: Open water.

Substrate: Eggs are scattered over mud, clay, rock, or gravel.

Water depth: 60-150 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in open lake.

Duration: Eggs hatch in spring.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Pelagic in open lake.

Substrate: No information.

Water Depth: Deep, open lake.

REFERENCES

Balon 1975; Lagler 1948; Smith 1969, 1978.

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[1] Now considered to be synonymous with shortjaw cisco.

LAKE HERRING

MIGRATION OF ADULTS

Prespawning: Shoreward movement to spawning grounds usually begins in late September-October when the water temperature reaches 43-41°F.

Postspawning: Movement away from spawning grounds occurs in December-January soon after spawning.

SPAWNING

Season: Late October-early January, but usually a 2-week period during late November-early December, when temperature is falling from 41-36°F; peak spawning occurs at 39-37°F.

Site: Shallow inshore areas, including shoals, beaches, bays, and tributaries; but also deep water adjacent to shoreline or farther offshore.

Substrate: Eggs are broadcast over clean, hard bottom, including rock, gravel, boulders, rubble, sand, clay, and marl; also reported to spawn over mud and vegetation.

Water Depth: 3-60 ft; but also to depths as great as 930 ft in Lake Superior.

INCUBATION AND HATCHING

Site: Eggs are demersal; incubate at spawning site.

Duration: Eggs hatch in 10-14 weeks at 40-43°F; hatching occurs just before ice breakup in late March-May.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae swim to surface immediately after hatching; during the first month of life they are found in protected bays; thereafter they move to deep water where they assume a pelagic existence.

Substrate: Larvae are found among rocks and vegetation.

Water Depth: Young-of-the-year are generally distributed from the surface to mid-depths in open water.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1903; Brooke and Colby 1980; Brown and Moffett 1942; Cahn 1927; Clady 1966; Colby and Brooke 1969, 1970, 1973; Crossman 1976; Eaton 1928; Edsall and Colby 1970; Engel and Magnuson 1971; Hay 1894; Hile 1936; Hinrichs and Brooke 1975;

Hubbs and Lagler 1958; John 1954, 1956; John and Hasler 1956; Johnson, J., 1956; Lagler 1948; Langlois 1941; MacKay 1959d, 1969; McCormick, Jones, and Syrett 1971; McCrimmon 1956; Ont. Game Fish 1934; Pearse 1921a; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Smith 1969; Stockwell 1876; U.S. Army Engin. Dist., Detroit, 1978, 1979; U.S. Comm. Fish Fish. 1900; Van Oosten 1927b, 1929; Wagner 1911; Washburn 1944.

LAKE WHITEFISH

MIGRATION OF ADULTS

Prespawning: Move inshore to spawning grounds; migration begins in September-October, but occasionally as early as August; historically also ascended rivers to spawn.

Postspawning: Return to deep water occurs soon after spawning.

Spawning

Season: A period of 2-5 weeks in October-January, when water temperature is falling from 53-33°F; spawning at temperatures above 43°F probably not successful; peak spawning usually occurs in late November-early December.

Site: Inshore areas, bays, ledges, shoals, reefs; often same sites used by lake trout.

Substrate: Eggs are broadcast near surface over hard, clean bottom, including stone, rubble, honeycombed rock, gravel, sand, and clay; use a wider variety of substrate types than lake trout; vegetation usually not present, but spawning over "moss" has been reported.

Water Depth: Several inches-100 ft, but usually less than 30 ft; often spawns on shallower portions of same reefs used by lake trout.

INCUBATION AND HATCHING

Site: Demersal eggs incubate on spawning substrate, often in crevices between and under rocks.

Duration: Eggs hatch in late March-May as the temperature approaches 43° F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Rise to surface soon after hatching; are carried onto shoals and to protected inshore areas, including bays and harbors; gradually move to the bottom and then to areas farther offshore.

Substrate: Rock and sand.

Water Depth: For about 2 months, larvae are found at the surface in less than 3 ft of water; in May-July, they move toward bottom in 10-80 ft of water; in September and October, they move to deeper water.

REFERENCES

Bean 1903, 1913, 1915; Bower 1898; Crossman 1976; Dymond 1926; Eaton 1928; FWS 1945; Greene et al. 1932; Hankinson 1908; Harris and Eschmeyer 1975; Hay 1894; Hile and Deason 1934; Hubbs and Lagler 1958; Kiel 1874; Lagler 1948; McCrimmon 1956; Peck 1975a; Price 1934, 1935; Scott 1957; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Suber 1920; U.S. Army Engin. Dist., Detroit, 1979; U.S. Comm. Fish Fish. 1900; Van Oosten 1939.

BLOATER

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: December-March, but ripe fish are found in all months and spent fish are found as early as August.

Site: Open lake.

Substrate: Eggs are broadcast pelagically over all bottom types, including clay, sand, and mud.

Water Depth: 120-400 ft.

INCUBATION AND HATCHING

Site: Semibuoyant clusters of eggs incubate just above bottom in spawning areas.

Duration: Hatching begins in early April and peaks in mid-June.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are most abundant near bottom, at water temperatures of 41° F or less; young-of-the-year (YOY) are pelagic.

Substrate: YOY are found over clay, sand, and rocks.

Water Depth: Usually greater than 240 ft; YOY that are occasionally found near shore at depths of less than 30 ft were probably carried there by upwellings.

REFERENCES

Balon 1975; Slastenenko 1958; Smith 1969.

DEEPWATER CISCO[1]

MIGRATION OF ADULTS

Prespawning: Move from deepwater to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: August and September.

Site: Open lake.

Substrate: Mud.

Water Depth: 360-540 ft.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Slastenenko 1958; Smith 1969.

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[1] This species is believed to be extinct in the Great Lakes.

KIYI

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: August-early January; peaks between mid-October and early November.

Site: Open lake.

Substrate: Mud.

Water Depth: 300-540 ft.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Slastenenko 1958.

BLACKFIN CISCO[1]

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water; historical indication of possible movement into bays.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: September-March, usually November-January.

Site: Open water.

Substrate: Eggs were scattered over rock, mud, and clay.

Water Depth: 90-600 ft.

INCUBATION AND HATCHING

Site: Eggs were pelagic in open water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae were pelagic in open water.

Substrate: No information.

Water Depth: No information.

REFERENCES

Balon 1975; Lagler 1948; Slastenenko 1958; Smith 1969.

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[1] This species is believed to be extinct in the Great Lakes.

SHORTNOSE CISCO

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: January-September, but usually April-June; peaks in early May; also believed to have spawned in November.

Site: Open water.

Substrate: Eggs are scattered over varied bottom types, including sand, mud, silt, clay, and rock.

Water Depth: 64-582 ft, but usually about 180-350 ft.

INCUBATION AND HATCHING

Site: Eggs are pelagic in open water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are pelagic in open water.

Substrate: No information.

Water Depth: No information.

REFERENCES

Balon 1975; Slastenenko 1958; Smith 1969.

SHORTJAW CISCO[1]

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water beginning in mid-September.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: A period of 1-2 weeks in October-early December; ripe fish found as early as mid-May.

Site: Open water.

Substrate: Eggs are scattered over clay and sand.

Water Depth: 60-300 ft; varies with weather conditions, shallow areas used in calm weather.

INCUBATION AND HATCHING

Site: Eggs are pelagic in open water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are pelagic in open water.

Substrate: No information.

Water Depth: No information.

REFERENCES

Balon 1975; Eddy and Underhill 1974; Lagler 1948; Slastenenko 1958; Smith 1969.

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[1] Now considered to be synonymous with longjaw cisco.

PINK SALMON

MIGRATION OF ADULTS

Prespawning: Congregate off tributary mouths beginning in mid-August; ascend tributaries to spawning grounds in September; upstream migration usually less than 0.5 mi but a migration of 40-50 mi has been reported in one Lake Superior tributary.

Postspawning: None; die soon after spawning.

SPAWNING

Season: A period of 3-5 days in September-early October at 60°F; usually peaks in mid-September.

Site: Usually in brush-choked streams in shoal area nearest stream mouth where there is suitable substrate and water velocity of 0.75-3.25 fps2/.

Substrate: Eggs are deposited in redd dug in medium-sized gravel.

Water Depth: 6 in.2/ - 2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs usually hatch in late December-late February; but hatching may sometimes occur as early as late November.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in gravel until yolk is absorbed; emerge in April-May, mainly mid-April, and immediately migrate downstream to lake; habitat occupied in Great Lakes by these young fish is unknown; young entering marine waters remain inshore for several months1/.

Substrate: No information.

Water Depth: No information.

REFERENCES

MacKay 1969; Scott and Crossman 19731/; Slastenenko 1958; Swift 19792/.

1/ Pacific Coast

2/ Washington

COHO SALMON

MIGRATION OF ADULTS

Prespawning: Congregate off tributary mouths in August and September; ascend tributaries to spawning grounds usually in September but sometimes in August; movement into tributaries correlated with increased flow.

Postspawning: None; die soon after spawning[1].

SPAWNING

Season: A 90-day period in mid-September-January when the temperature is falling from 57-40°F; spawning usually peaks in October or November; low temperatures in early winter can delay spawning until spring.

Site: Riffles, with water velocity of 0.25-2.5 fps[3], in mid-reaches or headwaters of streams; also reported along shore in St. Lawrence River.

Substrate: Eggs are deposited in redd dug in clean, small or medium-sized gravel; fine sediment detrimental to reproductive success.

Water Depth: Minimum depth reported as 6 in.[3] and also as shallow as 2 in.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs hatch in 2-5 months at 32-36°F; hatching usually occurs in March or April.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in gravel 2-16 weeks after hatching until yolk is absorbed; after emerging from gravel, inhabit shallows along sides of streams, then gradually move to deeper pools with slower current, usually under protection of overhanging banks, boulders, or logs[2]; remain in stream for at least one year.

Substrate: Those present in natal stream.

Water Depth: Those present in natal stream.

REFERENCES

Harry 1969[1]; Hartman 1965[2]; Scott and Crossman 1973; Smith 1969; Swift 1969[3]; Tody and Tanner 1966.

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[1] Pacific Coast

[2] British Columbia

[3] Washington

KOKANEE

MIGRATION OF ADULTS

Prespawning: Move from offshore waters to spawning grounds along the lakeshore and in tributaries; tributary runs begin in mid-August; peak in late September and end by mid-October.

Postspawning: None; die soon after spawning.

SPAWNING

Season: September-October when the temperature is falling from 61 to 41°F; peaks in late September or early October.

Site: Mid-reaches and headwaters of tributaries in areas with water velocity of less than 2.2 fps1/; if access to tributaries is denied spawning occurs along lake shore, usually on wave-swept beaches or on bars near stream mouths2/.

Substrate: Eggs are deposited in redds dug in fine gravel; also in sand along lake shores2/.

Water Depth: 1-30 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs hatch in 6-20 weeks at 59-39°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from redd in early January-May and descend to lake; downstream movement may occur under ice but peaks in mid-March to early May; habitat utilized in Great Lakes by these young fish is unknown.

Substrate: Those described for spawning site in lake; no other information.

Water Depth: Those described for spawning site in lake; no other information.

REFERENCES

Delisle 19621/; Eddy and Underhill 1974; Jeppson 19602/; Scott and Crossman 1973.

1/ California

2/ Idaho

CHINOOK SALMON

MIGRATION OF ADULTS

Prespawning: Congregate near tributary mouths usually in late August or September at about 70°F; upstream migration to spawning grounds may begin as early as mid-July, possibly initiated by drop in stream temperature to 65°; a spring run also occurs; spring-run fish inhabit deep pools in the stream until fall, when they spawn.

Postspawning: None; die soon after spawning.

SPAWNING

Season: Late August-mid November when temperature is falling from 50 to 37°F; peaks in October and may last several weeks.

Site: Riffle areas with water velocity of 1-3 fps[5,7] in high gradient mid-reaches or headwaters of tributaries; spawning may also occur along lake shore or on shoals [3,4].

Substrate: Eggs are deposited in redd dug in gravel and small rubble with good interstitial water flow, little mud or silt[1,6], depth of 18-30 in.[5], and diam. less than 6 in.[5], usually less than 1 in.[6]; if rocky substrate prevents redd construction, eggs may be deposited on the unmodified substrate.

Water Depth: 1-6 ft[3,5,7].

INCUBATION AND HATCHING

Site: Eggs incubate in layers of gravel in redd; also in crevices between rocks[1].

Duration: Eggs usually hatch in less than 4 months[2].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from gravel a few weeks after hatching; drift from spawning areas and remain near shore; may move downstream to lake during first summer of life or may remain in stream for 1-2 years[2]; most downstream movement occurs after heavy rain.

Substrate: Those described for spawning site or present in natal stream; no other information.

Water Depth: Those described for spawning site or present in natal stream; no other information.

REFERENCES

Burner 1951[1]; Harry 1969[2]; Hoover 1936[3]; Kendall 1913[4]; Leitritz and Lewis 1976[5]; Platts et al. 1979[6]; Scott and Crossman 1973; Swift 1979[7].

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[1] Columbia River

[2] Pacific Coast

[3,4] New Hampshire

[5] Laboratory studies

[6] Idaho

[7] Washington

PYGMY WHITEFISH

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds near shore; also ascend tributaries to spawn[1,2,3].

Postspawning: No information.

SPAWNING

Season: November-December, possibly into early January.

Site: Lakeshore or in tributaries.

Substrate: Eggs are scattered over rock, rubble, or coarse gravel.

Water Depth: Relatively shallow water.

INCUBATION AND HATCHING

Site: Eggs incubate among gravel and rock rubble.

Duration: Eggs hatch in early spring.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in littoral areas most of first summer of life; found on wave-swept ledges[1]; then move offshore.

Substrate: Sand[1].

Water Depth: 10-20 ft[1]; move to deeper water in late summer[1]; thereafter found at depths to about 200 ft.

REFERENCES

Eddy and Underhill 1974; Heard and Hartman 1966[1]; Kendall 1921[2]; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Weisel and Dillon 1954[3].

[1,2] Alaska

[3] Montana

ROUND WHITEFISH

MIGRATION OF ADULTS

Prespawning: Move inshore to spawning grounds in lake or tributaries beginning in September or October.

Postspawning: No information.

SPAWNING

Season: October-early January when temperature is falling from 40-36°F; spawning peaks in late November-early December.

Site: Along lakeshore, on beaches, shoals, and reefs, in bays, at river mouths; also in tributaries.

Substrate: Eggs are broadcast at the surface[1] over gravel, sand, and rock in areas free of silt[2].

Water Depth: Few inches[2] - 50 ft; usually less than 30 ft.

INCUBATION AND HATCHING

Site: Eggs settle to bottom[1] and incubate on substrate at spawning site.

Duration: Eggs hatch in about 140 days at 36°F; hatching begins in late March, peaks in late April, and ends by mid-May[2].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain on bottom[2]; young-of-the-year are found along shore and in river mouths.

Substrate: Rock, gravel, and sand with no emergent vegetation.

Water Depth: 5-15 ft.

REFERENCES

Balon 1975; Bean 1902, 1903, 1913; Eddy and Underhill 1974; Hubbs and Lagler 1958; Kendall and Goldsborough 1908[1]; Nash 1913; Normandeau 1969[2]; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; U.S. Comm. Fish Fish. 1900.

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[1] Connecticut

[2] New Hampshire

RAINBOW TROUT

MIGRATION OF ADULTS

Prespawning: Move into nearshore waters and enter tributaries in the fall, beginning in September, however the major run in most tributaries occurs in the spring; runs are stimulated by increased stream flow and water temperatures of 38-45°F.

Postspawning: Most return to lake immediately after spawning, usually by mid-June, but some remain in tributaries throughout the summer.

SPAWNING

Season: November-July at 33-65°F; peak spawning usually occurs in April-May at 43-46°F.

Site: Fast-water areas in mid-reaches or headwaters of cool, clear tributaries; may spawn along lake shore or on reefs or shoals if tributaries unsuitable.

Substrate: Eggs are deposited in redd dug in clean, small or medium-sized gravel.

Water Depth: Usually to depths of 6 ft; spawning in lake reported at depths to 36 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs spawned in the fall hatch the following spring; those spawned in the spring hatch in 1-2 months at 50-45°F, usually in late May-early July.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: In streams, remain in gravel for 2-3 weeks after hatching; fry first found in shallow areas near shore, then in deeper areas farther from shore; most remain in stream 1-4 years, but some may descend to lake during the first summer.

Substrate: Those present in the natal stream including gravel, rock, rubble, sand, mud, and silt.

Water Depth: To 4 ft. in natal stream.

REFERENCES

Bean 1913; Berst and McCombie 1975; Bower 1910; Eddy and Underhill 1974; Embody 1922, 1928; Hartman 1957, 1959; Hatch 1957a,b; Hubbs and Eschmeyer 1938; Johnson, C., 1971; Lagler 1948; MacKay 1960a, 1969; McCrimmon 1956; Moffett 1958; North Woods Call 1979a; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Smith and Moe 1944; Stone and Hartman 1957; USDI 1966, 1969b.

ATLANTIC SALMON[8]

MIGRATION OF ADULTS

Prespawning: Migrate long distances from lakes into tributaries and also into lake outlets[3,5,6]; runs stimulated by sudden increase in stream flow; some fish may be found in streams in most months; all approach shore in April-October, but at least two separate runs may occur; an early run ascends streams in May-July and remains in the streams until spawning time; a late run ascends in September and October just prior to spawning[1,2].

Postspawning: Most leave streams immediately after spawning or after resting in pools for a few weeks; others overwinter in streams.

SPAWNING

Season: A period of 5-14 days in late October-late December; peak spawning usually occurs in November at about 44°F.

Site: Fast-water areas in clear, cold streams with steep gradient; early runs usually spawn in the upper reaches, late runs in lower reaches; also on lake shoals which have seepage from springs[4,5,6,7].

Substrate: Eggs are deposited in redd dug in clean coarse gravel and small stones with good interstitial water flow; eggs may also be deposited directly on impenetrable substrate where redd construction is impossible[3].

Water Depth: To 4 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd[1] or on surface of impenetrable substrate[3].

Duration: Eggs hatch in 110-200 days at 39°F or less, in mid-March to early May but usually in April.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in gravel for 4-6 weeks; emerge in May or June; remain in rapids until 2.5 in. long, then move to slower areas at head of riffles and along edges of stream; young spawned in large rivers may ascend smaller tributaries near spawning site[5,6]; young remain in streams 1-3 years.

Substrate: Young are found on a variety of substrates, including gravel[3].

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Bean 1902; Belding 1934[1]; Belding and Kitson 1934[2]; Eddy and Underhill 1974; FWS 1945; Havey and Warner 1970[3]; Hoover 1937[4]; Kendall 1913[5], 1918[6]; MacKay 1960b, 1969; Ont. Game and Fish 1913a,b; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Towne 1959[7]; U.S. Comm. Fish Fish. 1900.

[1,2] Atlantic Coast of Canada

[3,6] Maine, land-locked population

[4,5,7] New Hampshire, land-locked population

[8] Native to Lake Ontario; native stocks extinguished before 1900.

BROWN TROUT

MIGRATION OF ADULTS

Prespawning: Enter and ascend tributaries in late summer and fall, beginning in July; runs are often limited by low stream flow.

Postspawning: Return to lake after spawning.

SPAWNING

Season: September-January; usually October-November when the temperature is falling from 55 to 44°F.

Site: Fast water in headwaters or mid-reaches of cool, shaded streams; if denied access to tributaries, spawning occurs on shoals near stream mouths, or elsewhere along shore.

Substrate: Eggs are deposited in redd dug in clean, coarse gravel and rubble or in firm sand or hard clay if gravel not available.

Water Depth: To 4 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel or on other substrate in redd.

Duration: Eggs hatch in 1-5 months at 57-35°F, usually in early February-early May.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from gravel and remain near bottom and stream bank in water with velocity of 0.5-1 fps; gradually move to deeper water farther from stream bank; young remain in natal stream 1-2 years before migrating to lake.

Substrate: Firm, clean stream bottom including gravel, rocks, and sand.

Water Depth: 6-16 in.

REFERENCES

Bean 1902, 1903, 1915; Benson 1953; Buller 1927; Calhoun and Coon 1941; Eddy and Underhill 1974; Embody 1922; Greeley 1932; Hansen 1975; Johnson, C., 1971; Lagler 1948; MacKay 1957c, 1969; Mansell 1966; Price and Kelly 1976; Scott 1967; Scott and Crossman 1973; Slastenenko 1958, USDI 1966, 1969b.

BROOK TROUT

MIGRATION OF ADULTS

Prespawning: Lake-run fish ("coasters") enter and ascend streams beginning in mid-August.

Postspawning: May return to lake after spawning.

SPAWNING

Season: August-March, but usually October-December, when the temperature is falling from 55 to 36°F.

Site: Riffles or pools near headwaters of clear, well-shaded streams, in spring-fed areas with gradient not more than 2%; also along lake shores with moderately swift current, usually near sites of upwellings.

Substrate: Eggs are deposited in redd dug in clean rubble, marl, or gravel.

Water Depth: 10 in.-5 ft in streams; to more than 8 ft in lakes1/.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel and sand in redd.

Duration: Eggs hatch in 32-165 days at 54-37°F, usually in February or March.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from gravel in January-May; remain in littoral areas close to spawning site for about 2 months, then move to deeper faster water 10-16 ft from streambank; also reported to move upstream into smaller tributaries1/ and to move downstream immediately after emergence2/.

Substrate: Varied bottom, including rock, gravel, sand, silt, and mud.

Water Depth: To 6 in. just after emergence; gradually move to deeper water.

REFERENCES

Benson 1953; Bean 1902, 1903, 1915; Brasch et al. 1962; Buller 1927; Calhoun and Coon 1941; Carline 1980; Crossman 1976; Dymond 1926; Eipper 1964; Embody 1922; Greeley 1932; Hazzard 1932; Johnson, C., 1971; Kendall 19181/; Lagler 1948; MacKay 1956d; Meehan 1895; Miller

1970; Milner 1874a; Moffett 1958; Nash 1913; Ont. Game Fish 1913a; Salli 1974; Scott and Crossman 1973; Shetter 1937, 1938a; Smedley 1938; Spangler and Berst 1978; U.S. Comm. Fish Fish. 1900; USDI 1966, 1969b; White 1930[2].

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[1] Maine

[2] Prince Edward Island, Canada

LAKE TROUT

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in shallower water on offshore reefs, in littoral waters, or in tributaries; movement usually begins in late August or September; fish arrive on grounds 1-2 weeks before spawning begins.

Postspawning: Disperse to deeper water several weeks after spawning.

SPAWNING

Season: Most spawning occurs in October and November when the temperature is falling from 58 to 37°F; however some races may begin spawning in June.

Site: Areas with current, including shorelines, reefs, shoals, ledges, bars, channels, bays, river mouths, and rivers.

Substrate: Eggs are broadcast by shallow-water races over rough, silt-free bottom, including honeycomb rock, rubble, boulders, and gravel; deep-water races spawn over clay, sand, mud, and silt; planted varieties spawn over all substrates.

Water Depth: Few inches - 600 ft, depending on race of lake trout; planted varieties usually at depths less than 30 ft.

INCUBATION AND HATCHING

Site: Eggs usually incubate in crevices in the substrate.

Duration: Eggs hatch in 2-5 months at 47-35°F, in late January-May.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in crevices in substrate for about 1 month; larvae produced in tributaries move into lake soon after hatching; young produced in lakes remain near spawning ground at least through first summer of life.

Substrate: Sand, rock, rubble.

Water Depth: To 150 ft.

REFERENCES

Bean 1902, 1903, 1913, 1915; Crossman 1976; Dymond 1926; Eaton 1928; Eddy and Underhill 1974; Fisherman 1936; FWS 1945; Greene 1955; Greene et al. 1932; Hacker 1957, 1962; Hubbs and Lagler 1958; Martin 1955, 1957, 1960, 1963; Martin and Baldwin 1960; McCrimmon 1956, 1958; Mich. State Comm. Superintendent State Fish. 1875; Moffett 1956, 1958; Ont. Game Fish 1916; Raney 1959; Royce 1936, 1951; Scott 1967; Scott and Crossman 1973; Smith and Moe 1944; Spangler and Berst 1978; Titcomb 1922; USDI 1966.

SPLAKE

MIGRATION OF ADULTS

Prespawning: Congregate on spawning grounds at appropriate depths in mid-October.

Postspawning: No information.

SPAWNING

Season: Mid-October to mid-November at 44-47°F.

Site: Shoals and reefs, especially former lake trout spawning grounds.

Substrate: Eggs are deposited on broken rock, boulders, rubble, and fine-coarse gravel that has been swept clean of silt, vegetation, and detritus.

Water Depth: 18 in. - 16 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on spawning substrate.

Duration: Eggs hatch in about 6 months, after spring ice breakup.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Martin and Baldwin 1960; Spangler and Berst 1978.

RAINBOW SMELT

MIGRATION OF ADULTS

Prespawning: Move from deep water to inshore areas and into tributaries over a period of 3-30 days; movement begins at about the time of ice breakup in late March or April at 33-40°F; downstream migration into lake outlets may also occur.

Postspawning: Disperse to offshore areas in late May-July immediately after spawning.

SPAWNING

Season: A period of 1-2 weeks in late March-July at 33-65°F; begins just after ice breakup and usually peaks in late April-early May at 40-50°F.

Site: Areas of moderate or swift current in tributaries, usually within 1 mi of mouth, and in wave-swept lake areas, including beaches, shoals, ledges, bars, and stream mouths.

Substrate: Eggs are broadcast over varied substrate, including gravel, cobble, rubble, boulders, bedrock, sand, mud, silt, and filamentous algae.

Water Depth: To 80 ft or more, but usually less than 12 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate at spawning site.

Duration: Eggs hatch in 2-4 weeks, usually in mid-May - July.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae drift out of natal stream into lake soon after hatching and frequent nearshore areas, including beaches, bays, harbors, and river mouths; older larvae disperse widely and are often found considerable distance from shore.

Substrate: Gravel, sand.

Water Depth: To 240 ft, but usually to 30 ft for larvae and to 60 ft for young-of-the-year; become demersal in the fall and move farther offshore.

REFERENCES

Berst and Spangler 1970a; Creaser 1925; Crossman 1976; Eaton 1928; FWS 1945; Greene 1930; Hubbs and Creaser 1924; Hubbs and Lagler 1958; Lagler 1948; Langlois 1935; ODNR, undated; Raney 1959; Smith 1964, 1969.

CENTRAL MUDMINNOW

MIGRATION OF ADULTS

Prespawning: Move onto flooded stream banks; also may migrate extensively upstream beginning in mid-February or March.

Postspawning: No information.

SPAWNING

Season: Mid-March-late April, during spring floods, at about 55°F.

Site: Backwaters, lagoons, ditches, and flooded areas with sluggish water movement.

Substrate: Eggs are deposited singly on soft bottom or vegetation; sometimes also on stones.

Water Depth: About 1 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation or substrate at spawning site.

Duration: Eggs hatch in about 6 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in littoral areas near spawning site; move to main stream when just over 1 in. long.

Substrate: Soft bottom, including mud, silt, and vegetation.

Water Depth: About 1 ft.

REFERENCES

Adams and Hankinson 1928; Eddy and Underhill 1974; Evermann and Clark 1920; Faber 1967; Gill 1904; Hubbs and Lagler 1958; ODNR, undated; Peckham 1955; Peckham and Dineen 1957; Scott 1957; Scott and Crossman 1973; Westman 1941, as cited in Scott and Crossman 1973.

GRASS PICKEREL

MIGRATION OF ADULTS

Prespawning: Congregate at tributary mouths when ice begins to breakup; ascend streams just after ice breakup, usually beginning in late February.

Postspawning: No information.

SPAWNING

Season: Late March-early May at 43-53°F, during spring flood; also reported to spawn in the fall.

Site: Marshes, lagoons, sloughs, ditches, and flooded land with sluggish water movement.

Substrate: Eggs are scattered over muck, silt, peat, detritus, or vegetation.

Water Depth: 2 in. - 3 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation or detritus at the spawning site.

Duration: Eggs hatch in 11-20 days at 46-48° F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain near bottom at spawning site for 10-14 days and may attach to vegetation; fry migrate to lake when about 1 in. long.

Substrate: Soft bottom.

Water Depth: To 3 ft for larvae.

REFERENCES

Buss et al. 1978; Buss and Miller 1967; Cahn 1927; Carbine 1938, 1944; Crossman 1962, as cited in Scott and Crossman 1973; Fowler 1921; Hankinson 1908; Karvelis 1964; Kirsch 1895; Kleinert and Mraz 1966; Lagler and Hubbs 1943; McNamara 1937; Richardson 1913a; Scott 1967; Slastenenko 1958; Van Oosten 1960.

NORTHERN PIKE

MIGRATION OF ADULTS

Prespawning: Migrate from deeper water to littoral areas or into tributaries at time of ice breakup, beginning at about 33-40°F; may begin to congregate at river mouths in late February before ice breakup.

Postspawning: Return to lake after spawning.

SPAWNING

Season: A period of 10-24 - days in mid-March - June, after ice leaves streams, at 35-64°F; usually late March-late April at 40-50°F.

Site: Areas with sluggish water current, including shoreline weed beds and marshes, sloughs, bays and harbors, backwaters, river mouths, ditches, feeder streams, and temporarily flooded lowlands.

Substrate: Eggs are scattered over soft bottom, with abundant emergent and submergent vegetation; may also spawn over gravel and rock.

Water Depth: To 24 ft, but usually less than 6 ft and often less than 2 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation or debris at spawning site.

Duration: Eggs hatch in 1 - 3-1/2 weeks, usually in 10-18 days at 52-42°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain attached to vegetation at spawning site for 5-10 days; young remain in sheltered, weed-choked areas; young produced in tributaries move downstream to harbors and lakeshores when they are 1-2 in. long.

Substrate: Soft bottom with abundant vegetation.

Water Depth: 1 - 2-1/2 ft; move to deeper water in late summer.

REFERENCES

Alldridge and White 1980; Allen 1914; Bensley 1915; Bean 1903, 1912, 1913; Bennett 1948; Buss 1960, 1961; Buss et al. 1978; Cahn 1927; Calhoun and Coon 1941; Carbine 1938, 1941, 1944; Crossman 1976; Dymond 1926; Eddy and Underhill 1974; Embody 1915, 1918, 1922; Evermann and Latimer 1910; Faber 1963; Forny 1967, 1968; Franklin and

Smith 1963; Greely 1928; Hubbs and Eschmeyer 1938; Hubbs and Lagler 1958; Johnson, C., 1971; Johnson, F., 1957; Jordan 1877; Karvelis 1964; Kramer and Smith 1960; Lagler 1948; Leach 1927; MacKay 1959f, 1969; McCrimmon 1956; McNamara 1937; Nash 1913; Peterka and Kent 1976; Price and Kelly 1976; Priegel and Krohn 1975, 1971; Raney 1959; Reighard 1913; Scott 1967; Scott and Crossman 1973; Shetter 1937; Slastenenko 1958; Smith and Moe 1944; Smith et al. 1958; Spinner 1968; Surber 1920; Threinen and Oehmke 1950; Threinen et al. 1966; Titcomb 1922; USDI 1966, 1969b; Van Oosten 1946, 1960; Westerman 1946; Williams 1954a; Williams and Jacob 1971; Williamson 1942.

MUSKELLUNGE

MIGRATION OF ADULTS

Prespawning: Make extensive migrations into tributaries, often to the headwaters, or to lake shallows, when the temperature rises to 42°F, following ice breakup.

Postspawning: Males return to lake when water temperature reaches about 60°F; females remain in river channels several weeks and return to lake by mid-August.

SPAWNING

Season: Late March-June at 46-65°, but usually May and June.

Site: Protected bays, harbors, marshes, stream mouths, feeder streams, and flooded lowlands; also in current-swept areas at edges of channels.

Substrate: Eggs are scattered over mud, muck, clay, or sand with decayed vegetation and woody debris, including brush, logs, and stumps.

Water Depth: 6 in. - 15 ft; usually less than 3 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on vegetation and debris at spawning site.

Duration: Eggs hatch in 8-15 days at 62-50°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain among vegetation for about 10 days; young may remain near spawning site for several months or may drift into deeper waters of bays and marshes as shallows dry up.

Substrate: Mud, silt, sand, vegetation.

Water Depth: To 6 ft, near surface.

REFERENCES

Bean 1903, 1908, 1913, 1915; Becker 1976; Bensley 1915; Buss 1960; Buss et al. 1978; Calhoun and Coon 1941; DeBoer and Williams 1954; Dombeck 1979; Eddy and Underhill 1974; Faber 1963, 1967; Forney, undated; Garland 1973; Hay 1894; Hubbs and Lagler 1958; Johnson, C., 1971; Johnson, L., 1958; Karvelis 1964; Leach 1927; MacKay 1931, 1956c, 1969; McCrimmon 1956; Minor and Crossman 1978; Nevin 1901a; ODNR, undated; Oehmcke et al. 1962; Ont. Game Fish 1913b, 1930; Price and Kelly 1976; Raney 1959; Scott 1967; Scott and Crossman 1973;

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Slastenenko 1958; Smith and Moe 1944; Surber 1920; Threinen and Oehmke 1950; U.S. Comm. Fish Fish. 1900; USDI 1966, 1969b; Van Oosten 1946, 1960; Webster 1929; Wickcliff 1933b; Williams 1954a,b, 1959; Williamson 1942; Winchester 1912.

STONEROLLER

MIGRATION OF ADULTS

Prespawning: Ascend small streams beginning in February.

Postspawning: No information.

SPAWNING

Season: Late March-early July at 53-80°F.

Site: Clear smoothly flowing water, at head of riffle near deeper pool or overhanging bank.

Substrate: Eggs are deposited in a nest constructed by male in gravel, rock, and sand.

Water Depth: 6 in. - 2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in crevices among gravel in nest.

Duration: Eggs hatch in about 3 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: Gravel[1].

Water Depth: No information.

REFERENCES

Breder and Rosen 1966; Cahn 1927; Eddy and Underhill 1974; Fish 1932; Fowler 1909; Hankinson 1919, 1932; Hubbs and Cooper 1936; Meek and Hildebrand 1910; Miller 1962, 1964; Minckley 1963[1]; Raney 1949; Reed 1958; Reighard 1913; Smith 1935, Trautman 1957.

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[1] Kentucky

GOLDFISH

MIGRATION OF ADULTS

Prespawning: Move inshore short distances into littoral areas or tributaries beginning at about 45°F.

Postspawning: No information.

SPAWNING

Season: Mid-April - mid-August, usually May and June, beginning at about 55°F; spawning may continue throughout the summer if water temperature remains above 60°F.

Site: Current-free areas in lower reaches of rivers, bays, harbors, lagoons, marshes, and flooded lowlands.

Substrate: Eggs are scattered over thick vegetation and mud, sand, clay, or gravel; also deposited on undersides of boats and harbor pilings.

Water Depth: 2-12 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate, usually vegetation, at spawning site.

Duration: Eggs hatch in 2-1/2 to 7 days at 82-60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young frequent river mouths, harbors, and protected shoreline areas through the first summer of life.

Substrate: Vegetation and mud.

Water Depth: 1-7 ft.

REFERENCES

Dobie et al. 1956; Embody 1915; Hubbs and Cooper 1936; Scott 1967.

LAKE CHUB

MIGRATION OF ADULTS

Prespawning: Migrate from deeper water to littoral areas or ascend tributaries for short distances.

Postspawning: Return to lake from tributaries after spawning.

SPAWNING

Season: April-early July.

Site: Tributaries and lake shores.

Substrate: Sand, gravel, and rubble.

Water Depth: Ripe fish found at 3-30 ft.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year found in streams, stream mouths, and along lake shores.

Substrate: No information.

Water Depth: No information.

REFERENCES

Dymond 1926; Eddy and Underhill 1974; Radforth 1944; Scott 1967; Scott and Crossman 1973; Slastenenko 1958.

CARP

MIGRATION OF ADULTS

Prespawning: Move from littoral waters into marshes beginning in April or early May at about 45°F; also ascend tributaries, usually only short distances, but sometimes as far as 10-15 mi.

Postspawning: Disperse after spawning but remain in shallows throughout the summer; move to depths greater than 6 ft in late August; tributary spawners return to lakes by early June.

SPAWNING

Season: May-August at 52-90°F; peak spawning occurs in late May-early June at 65-73°F; spawning may extend throughout summer subject to interruption by cool weather.

Site: Protected areas of lakes and rivers, including bays, harbors, marshes, backwaters, sloughs, flooded shorelines, and river mouths; also on shoals and reefs.

Substrate: Eggs are broadcast at random near the surface over mud, muck, silt, sand, matted roots or dead grass, and abundant emergent, submergent, and floating vegetation; also over gravel, rock, and rubble.

Water Depth: To 20 ft, but usually less than 3 ft, and often 3 in. - 1 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on firm substrate including plants, dead grass, tree roots, stones, and *Cladophora* fronds (thalli).

Duration: Eggs hatch in 1-3 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae settle to bottom immediately after hatching and attach to plants or other objects; fry tend to leave spawning areas about 2 weeks after hatching but remain along shore among vegetation through summer; larvae are also abundant in riffle areas in rivers.

Substrate: Mud, clay, gravel, rock, sand, and vegetation.

Water Depth: About 1 in. for newly hatched larvae; 4-6 in. for young-of-the-year (YOY) about 0.5-1 in. long; 6-12 in. for those 1-3 in. long; in late summer YOY 3-4 in. long are found to depths of 20 ft but they are usually in 1-2 ft of water.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Bean 1903; Becker 1976; Brasch 1958; Cahn 1927; Eaton 1928; Eddy and Underhill 1974; Embody 1915, 1922; Evermann and Clark 1920; Frey 1940; FWS 1945; Gammon 1976; Greeley 1928; Harris et al. 1882; Hubbs and Cooper 1936; Hubbs and Lagler 1958; Kramer and Smith 1960b; Lagler 1948; MacKay 1960c, 1969; McCrimmon 1956; McCrimmon and Swee 1967; Miller 1952; Mraz and Cooper 1957; Nash 1913; Price and Kelly 1976; Raney 1959; Richardson 1913b; Scott 1967; Slastenenko 1958; Smallwood and Struthers 1928, 1931; Smith and Moe 1944; Struthers 1929, 1931; Taft 1975; USDI 1966, 1969b; Wickliff 1936, 1957.

SILVERJAW MINNOW

MIGRATION OF ADULTS

Prespawning: May move from streams into smaller creeks.

Postspawning: No information.

SPAWNING

Season: Late April-late July; spawning peaks in late April-early May and late June-early July.

Site: Streams.

Substrate: Eggs are scattered over clean sand and gravel.

Water Depth: 2-3 in.

INCUBATION AND HATCHING

Site: Eggs incubate on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are collected upstream in creeks and also in the lower reaches of rivers.

Substrate: Sand.

Water Depth: No information.

REFERENCES

Forbes and Richardson 1920; Hankinson 1919; Osburn 1901; Smith 1963; Wallace 1973.

SILVER CHUB

MIGRATION OF ADULTS

Prespawning: Historically ascended rivers.

Postspawning: No information.

SPAWNING

Season: Late May-early August at 66-74°F; peak spawning occurs in late June-early July at 73°F.

Site: Historically rivers; presently beaches, bays, open lake.

Substrate: Eggs are scattered in mid-water over clean gravel.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Possibly open water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Open lake; possibly also on reefs.

Substrate: No information.

Water Depth: No information.

REFERENCES

ODNR, undated; Raney 1969a; Slastenenko 1958.

RIVER CHUB

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Mid-May - early July at 60-83°F.

Site: River shoals or lower pools just above riffles, in slow or moderate current 2-10 ft from shore.

Substrate: Eggs are scattered in nest made in clean gravel.

Water Depth: 6 in. to 2-1/2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in nest constructed of stones to form a low mound up to 4 ft in diameter.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Forbes and Richardson 1920; Greeley 1929; Hankinson 1920, 1932; Lachner 1952; Miller 1964; Raney 1949, 1969a; Reighard 1943; Hubbs and Cooper 1936; White et al. 1975; Wickliff 1957.

GOLDEN SHINER

MIGRATION OF ADULTS

Prespawning: Movement to shallows may begin as early as April.

Postspawning: No information.

SPAWNING

Season: Mid-May to early August at 60-80°F; spawning may occur throughout the summer; peak spawning occurs in mid-June - July.

Site: Sheltered areas of lakes, including bays, marshes, lagoons, sloughs, and creek mouths.

Substrate: Eggs are scattered over dense vegetation, mud, silt, and detritus; also reported to spawn in largemouth bass nests.

Water Depth: To 4-1/2 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on vegetation at spawning site.

Duration: Eggs hatch in 7-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Sheltered areas near spawning site, including marshes, harbors, and river mouths.

Substate: Sand, mud, silt, and vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Buller 1927; Cahn 1927; Cooper 1935, 1938; Eddy and Underhill 1974; Embody 1915, 1922; Forbes and Richardson 1920; Forney 1956; Greeley 1929; Hedges and Ball 1953; Hubbs and Cooper 1936; Kramer and Smith 1960a,b; Langlois 1954; ODNR, undated; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Smith and Moe 1944; Surber 1940.

PUGNOSE SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: June or July.

Site: Protected areas, such as bays.

Substrate: Gravel, sand, and mud, with vegetation.

Water Depth: Shallow; no specific information.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Protected areas.

Substrate: Sand, mud, and vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

ODNR, undated; Scott and Crossman 1973.

EMERALD SHINER

MIGRATION OF ADULTS

Prespawning: Move from deep water to inshore areas beginning as early as May at 64°F; also enter harbors and creek mouths.

Postspawning: Disperse to deeper water soon after spawning.

SPAWNING

Season: Mid-May to late August, usually June and July, at 68-74°F.

Site: Open lake often several miles from shore and clear, quiet areas along shore, in harbors, and in rivers.

Substrate: Eggs are scattered at surface or midwater over sand, gravel, or rock, with or without vegetation.

Water Depth: To 42 ft or more.

INCUBATION AND HATCHING

Site: Nonadhesive eggs incubate in open lake or on vegetation.

Water Depth: Eggs hatch in 24-32 hours.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae lie on bottom for about 4 days until they are free-swimming; large schools of young-of-the-year occur in clear, quiet water along shore, in bays, and river mouths, and several miles offshore; all move offshore by late summer.

Substrate: Sand, rock, clay, silt, and vegetation.

Water Depth: Usually in the upper 6-12 ft of water, over depths to 200 ft.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Campbell and MacCrimmon 1970; Dymond 1926; Fish 1929; Gordon 1968; Greeley 1928; Raney 1969b; Trautman 1957.

BRIDLE SHINER

MIGRATION OF ADULTS

Prespawning: Little movement.

Postspawning: Little movement.

SPAWNING

Season: Mid-April to mid-July, at 58-80°F[1].

Site: Still water, 9-30 ft from shore, in creeks and lakes.

Substrate: Eggs are scattered near surface in open water, 6-18 in. above submerged vegetation growing in silt and detritus.

Water Depth: To 2 ft.

INCUBATION AND HATCHING

Site: Eggs settle onto vegetation.

Duration: 2-1/2 to 3 days[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry remain among vegetation for about 2 weeks, then move to more open water in littoral zone.

Substrate: Vegetation initially; then move to bottom with little vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Fowler 1909; Harrington 1947a,b[1]; Raney 1969b.

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[1] New Hampshire

COMMON SHINER

MIGRATION OF ADULTS

Prespawning: Migrate to lake shores and ascend creeks in early May at 55-60°F.

Postspawning: Return to lake after spawning.

SPAWNING

Season: A period of 10-days in mid-May to late July at 58-83°; peak spawning occurs at 74°F.

Site: Fast-water areas in or near stream riffles, in stream mouths, and on lake shoals.

Substrate: Eggs are deposited in a depression made in clean gravel or possibly sand; prefers to spawn over nests cleared by other species, such as smallmouth bass or chubs.

Water Depth: To 3 ft, but usually 8-10 in.

INCUBATION AND HATCHING

Site: Slightly adhesive eggs fall among gravel and are buried.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in streams, first in pools and then also in fast water; also found along lakeshores.

Substrate: No information.

Water Depth: 5 ft.

REFERENCES

Adams and Hankinson 1928; Becker 1976; Bensley 1915; Cooper 1938; Eddy and Underhill 1974; Forbes and Richardson 1920; Greeley 1927; Hankinson 1908, 1920, 1932; Hubbs and Cooper 1936; Lachner 1952; Miller 1964; Moyle 1973; Nash 1913; Nurnberger 1931; Osburn and Williamson 1898; Parker et al. 1899; Price and Kelly 1976; Raney 1940b, 1949, 1969a; Reighard 1915; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Trautman 1957.

PUGNOSE MINNOW

MIGRATION OF ADULTS

Prespawning: Reported to migrate into bays in mid-late April.

Postspawning: No information.

SPAWNING

Season: June - mid-July.

Site: No information.

Substrate: Vegetation required.

Water Depth: No information.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: Vegetation required.

Water Depth: No information.

REFERENCES

Becker 1976; Scott and Crossman 1973; Slastenenko 1958.

BLACKCHIN SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Mid-May to late July.

Site: Sheltered locations, including weed beds.

Substrate: Eggs are scattered over vegetation.

Water Depth: Shallow.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on submerged vegetation.

Duration: No informtion.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: Vegetation and mud.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Eddy and Underhill 1974; Hankinson 1908; Raney 1969b; Slastenenko 1958.

BLACKNOSE SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Mid-May to August.

Sites: Lakes, ponds, and streams.

Substrate: Eggs are scattered over sand or fine roots of vegetation growing in sand.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate or on roots.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year frequent weedy areas and are numerous in lagoons.

Substrate: Sand, vegetation.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Cahn 1927; Dymond 1926; Moore 1922; ODNR, undated; Raney 1969b; Scott and Crossman 1973.

SPOTTAIL SHINER

MIGRATION OF ADULTS

Prespawning: Migrate inshore as early as March; also enter harbors and stream mouths and may ascend 200-300 yd upstream.

Postspawning: Disperse offshore to depths of 19-46 ft in July and August after spawning.

SPAWNING

Season: Late April-late August, but usually June and July at 64-72°F.

Site: Quiet, protected nearshore areas, including shorelines, beaches, shoals, bays, and stream mouths.

Substrate: Eggs are scattered over clean sand, rock, gravel, and vegetation.

Water Depth: To 30 ft, but often less than 1 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on substrate, among masses of Cladophora, or on other vegetation.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Protected nearshore areas, including shorelines, beaches, shoals, bays, lagoons, and stream mouths.

Substrate: Sand, gravel, rock, and vegetation.

Water Depth: To 30 ft; move to deeper water in early fall.

REFERENCES

Adams and Hankinson 1928; Becker 1976; Dymond 1926; Eddy and Underhill 1974; Gordon 1968; Greeley 1928; Hubbs 1923; Hubbs and Cooper 1936; Osburn 1901; Raney 1969b; Reighard 1915; Scott 1967; Slastenenko 1958; Smith and Kramer 1964.

ROSYFACE SHINER

MIGRATION OF ADULTS

Prespawning: Little movement; move onto shoals and riffles at about 68°F.

Postspawning: No information.

SPAWNING

Season: Mid-May to mid-July at 68-84°F.

Site: Stream riffles or small pools below riffles in areas of moderate to swift current.

Substrate: Eggs are scattered several inches above a bottom of clean gravel, sand, rubble, limestone shingles, or bedrock; also over nests of chubs.

Water Depth: 8-16 in.

INCUBATION AND HATCHING

Site: Eggs develop on substrate at spawning site.

Duration: Eggs hatch in about 2-1/2 days at 70°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in bays.

Substrate: No information.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Bean 1915; Eddy and Underhill 1974; Forbes and Richardson 1920; Hankinson 1920, 1932; Hubbs and Brown 1929; Hubbs and Cooper 1936; Lachner 1952; Miller 1964; Parker et al. 1899; Pfeiffer 1955; Price and Kelly 1976; Raney 1969b; Reed 1957; Slastenenko 1958; Trautman 1957.

SPOTFIN SHINER

MIGRATION OF ADULTS

Prespawning: Little movement.

Postspawning: Little movement.

SPAWNING

Season: Mid-May to late August at 65-85°F.

Site: Stream riffles; also in sheltered areas, such as weed beds, harbors, and creek mouths, at locations with a slight current.

Substrate: Masses of eggs are deposited under loose bark or in crevices of submerged branches, logs, tree roots, or pilings on firm bottom of gravel or sand; occasionally scattered over exposed substrate.

Water Depth: 1-4 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on the spawning substrate.

Duration: Eggs hatch in 5 days at 72°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in quiet pools below spawning riffles, in lower reaches of rivers, and in river mouths.

Substrate: No information.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Hankinson 1930; Hubbs and Cooper 1936; Osburn and Williamson 1898; Pflieger 1960, 1965; Raney 1969b; Schlueter 1977; Scott 1967; Slastenenko 1958; Stone 1940; Trautman 1957.

SAND SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Late May-July, beginning at about 70°F.

Site: Lake shoals, beaches, and sheltered locations, including bays creek mouths, and harbors.

Substrate: Eggs are scattered over clean gravel or sand or roots of plants.

Water Depth: Shallow; no specific information.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year prefer sheltered locations, including lagoons, river mouths, and lower reaches of rivers.

Substrate: Sand, gravel.

Water Depth: Shallow, no specific information.

REFERENCES

Balon 1975; Dymond et al. 1929; Hubbs and Cooper 1936; ODNR, undated; Raney 1969b; Smith 1963.

MIMIC SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Mid-May to mid-August.

Site: Clear, quiet water in weed beds and harbors and on shoals and sand bars.

Substrate: Eggs are broadcast over vegetation or other objects on sand bottom.

Water Depth: Shallow; possibly to 15-20 ft.

INCUBATION AND HATCHING

Site: Eggs incubate at spawning site.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in sheltered areas, including bays and coves.

Substrate: Sand, mud.

Water Depth: To 20-30 ft.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Black 1945; Moyle 1973; ODNR, undated; Raney 1969b.

NORTHERN REDBELLY DACE

MIGRATION OF ADULTS

Prespawning: Ascend streams in April and May.

Postspawning: Return to lake after spawning.

SPAWNING

Season: May-August at 65-78°F; two spawnings may occur.

Site: Riffles and quiet water in streams.

Substrate: Eggs are scattered over masses of filamentous algae on gravel; also over nests of chubs.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Eggs incubate among filamentous algae or clumps of rootless vegetation.

Duration: Eggs hatch in 8-10 days at 80-70°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Cahn 1927; Cooper 1935, 1938; Dymond 1926; Hankinson 1932; Hubbs and Cooper 1936; Lachner 1952; Price and Kelly 1976; Raney 1969a; Scott 1967; Smith and Moyle 1944.

BLUNTNOSE MINNOW

MIGRATION OF ADULTS

Prespawning: Usually little movement, but may enter and ascend creeks.

Postspawning: Male remains at spawning site to guard eggs and fry.

SPAWNING

Season: April-September at 65-82°F, but usually May-July.

Site: Quiet, protected inshore areas, including lake margins, shoals, lagoons, marshes, harbors, creek mouths, and stream pools.

Substrate: Masses of eggs are deposited on the flat undersides of stationary objects, such as stones, sticks, or boards, on firm bottom of sand, gravel, or rock.

Water Depth: To 8 ft, but usually less than 3 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: Eggs hatch in 1-2 weeks at 80-70°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year remain near spawning sites in marshes, lagoons, beaches, harbors, creek mouths, and shoals.

Substrate: Firm bottom.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Cahn 1927; Cooper 1935, 1938; Dymond et al. 1929; Eigenmann 1896; Evermann and Clark 1920; Forbes and Richardson 1920; Forney 1956; Greeley 1927; Greeley and Bishop 1932; Hankinson 1908, 1919, 1920, 1932; Hay 1894; Hubbs and Cooper 1936; Hubbs and Lagler 1958; Lake 1936; Langlois 1954; Moyle 1973; Osburn and Williamson 1898; Parker et al. 1899; Price and Kelly 1976; Raney 1949; Reighard 1913, 1915; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith 1963; Surber 1940; Trautman 1957; Van Cleave and Markus 1929; Voris 1899; Wascko and Clark 1951; Westman 1938; White et al. 1975; Wickliff 1957; Winn 1958.

FATHEAD MINNOW

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male remains at spawning site to guard nest.

SPAWNING

Season: Late April-early September at 60-85°F; spawning occurs more than once, and the season extends through most of the summer.

Site: Protected areas, such as lake margins and marshes.

Substrate: Eggs are laid in a nest hollowed out in mud or sand under submerged objects, such as rocks, sticks, or cans; they are deposited in a mass on the underside of the objects.

Water Depth: 3-18 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on the spawning substrate.

Duration: Eggs hatch in 4-6 days at about 77°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in protected areas, such as marshes, harbors, and creek mouths.

Substrate: Mud, sand.

Water Depth: Shallow; no specific information.

REFERENCES

Becker 1976; Cahn 1927; Cooper 1938; Dobie et al. 1956; Dymond 1926; Eddy and Underhill 1974; Forney 1956; Greeley 1927; Hedges and Ball 1953; Hubbs and Cooper 1936; Langlois 1954; ODNR, undated; Raney 1949; Scott 1967; Slastenenko 1958; Trautman 1957; Wascko and Clark 1951; Williamson 1939.

BLACKNOSE DACE

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Late May to mid-July, beginning at about 70°F.

Site: Stream riffles.

Substrate: Eggs are broadcast on clean gravel, rubble, or sand; also in creek chub nests.

Water Depth: 2-8 in.

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year (YOY) are found on shoals near stream margins; move to quiet pools as they grow[1].

Substrate: Mud.

Water Depth: No specific information; YOY move from shallows to deeper water.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Eddy and Underhill 1974; Forbes and Richardson 1920; Greeley 1929, 1934; Hubbs and Cooper 1936; Minckley 1963[1]; Parker et al. 1899; Price and Kelly 1976; Raney 1940a, 1969a; Slastenenko 1958; Smith and Moyle 1944; Traver 1929.

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[1] Kentucky

LONGNOSE DACE

MIGRATION OF ADULTS

Prespawning: Migrate inshore or into streams in mid-April to late May at about 46-57°F.

Postspawning: Return to lake after spawning.

SPAWNING

Season: Late April-late July at 52-75°; spawning peaks at 57-66°F.

Site: Stream riffles, river mouths, and wave-swept lake shores, beaches, and bars.

Substrate: Eggs are deposited on sand, gravel, rubble, and rock of 3-4 in. diam.; also over nests of river chubs1/.

Water Depth: To 10 ft, but usually less than 1 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on spawning substrate.

Duration: Eggs hatch in 3-4 days at 70°F2/.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae hide among rocks for about 1 week, then rise to surface; young-of-the-year are pelagic in quiet nearshore areas, river mouths, lower reaches of rivers, beaches, shoals, and breakwaters.

Substrate: Gravel, sand, rock.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Becker 1962, as cited in Becker 1976; Cooper 19801,2/; Dymond 1926; Eddy and Underhill 1974; Scott and Crossman 1973; Slastenenko 1958.

1/ Pennsylvania, West Virginia, Maryland

2/ Laboratory study

CREEK CHUB

MIGRATION OF ADULTS

Prespawning: Migrate upstream in creeks in late March; also move inshore in lakes.

Postspawning: Both parents desert nest after spawning.

SPAWNING

Season: April-early July at 55-80°F.

Site: Smooth, swift water, with a velocity of 1-2 fps, just above riffles in small, clear streams; also littoral zones of lakes.

Substrate: Eggs are deposited in a depression made in coarse gravel, sand, or rubble; also over nest of common shiner and stoneroller.

Water Depth: 3-12 in., but usually 5-6 in.

INCUBATION AND HATCHING

Site: Nonadhesive eggs drop to bottom of nest, a trench up to several feet long with a ridge of stones on upstream edge, and are subsequently covered with gravel and stones.

Duration: Eggs hatch in 6-10 days at 65-55°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain under gravel; young-of-the-year are found in quiet water in streams or in protected areas along lake shores.

Substrate: Sand, gravel, some vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Becker 1976; Buynak and Mohr 1979b; Cahn 1927; Copes 1978; Eddy and Underhill 1974; Embody 1914; Greeley 1934; Hankinson 1908, 1919, 1932; Hedges and Ball 1953; Hubbs and Cooper 1936; Hubbs and Lagler 1958; Lagler 1948; Markus 1934; Miller 1964; Nash 1913; Raney 1969a; Reighard 1910; Ross 1977; Scott and Crossman 1973; Slastenenko 1958; Smith and Moyle 1944; Smith 1963; Washburn 1948; Wickliff 1957.

FALLFISH

MIGRATION OF ADULTS

Prespawning: Move to lake margins and probably ascend streams.

Postspawning: Both male and female remain to guard nest.

SPAWNING

Season: Late April to mid-June, beginning at 54[2] - 58°F[1].

Site: Quiet water just above or below stream riffles, and on lake margins and shoals.

Substrate: Eggs are deposited in a depression made in gravel.

Water Depth: 18 in.[3] - 3 ft.

INCUBATION AND HATCHING

Site: Eggs drop to bottom of nest, a cleared area up to several feet long with a high mound of pebbles on upstream edge, and are subsequently covered with gravel.

Duration: Eggs hatch in 20 days at 63°F[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in gravel about 5 days[1] until yolk sac is absorbed; fry remain over nest area for a short period; older young-of-the-year are found along shore.

Substrate: Vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Embody 1922; Fowler 1909, 1932; Greeley 1934; Miller 1964; Raney 1949, 1969a; Reed 1971[1]; Richardson 1935[2], as cited in Scott and Crossman 1973; Ross and Reed 1978[3]; Slastenenko 1958.

[1,3] Massachusetts

[2] Quebec

RIVER CARPSUCKER

MIGRATION OF ADULTS

Prespawning: Move to current-swept areas and ascend rivers[2/].

Postspawning: Return to deep water after spawning[2/].

SPAWNING

Season: April-July at 57-82°F[1,2,3,4/].

Site: Large tributaries[3/].

Substrate: Eggs are scattered over firm sand[3,5/].

Water Depth: 1-3 ft[5/].

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on objects onto which they settle[3,5/].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year remain in large tributaries[3/] or move downstream to harbors.

Substrate: Sand[3/].

Water Depth: Shallow[3/]; no specific information.

REFERENCES

Buchholz 1957[1/]; Curry and Spacie 1979; Hodson 1973[2/]; June 1977[3/]; Walburg and Nelson 1966[4,5/].

1/ Iowa

2/ Texas

3,4/ South Dakota

5/ Oklahoma

QUILLBACK

MIGRATION OF ADULTS

Prespawning: Lake-run fish migrate inshore and into harbors and lower reaches of rivers in April and May; riverine stocks migrate upstream into very small creeks.

Postspawning: Move downstream in late summer or fall.

SPAWNING

Season: Mid-April to July at 50-68°F.

Site: Lake-run fish spawn along lake shores, on shoals, and in bays, harbors, and lower rivers; riverine stocks spawn in small creeks.

Substrate: Eggs are scattered at random over sand, gravel, clay, mud, rock, and vegetation.

Water Depth: 1-6 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on substrate at spawning site.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in sheltered areas along lake shores, in harbors, lower rivers, and low-gradient streams; stream-spawned fish drift downstream in late summer or early fall.

Substrate: Sand, mud, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Currie and Spacie 1977; Evermann and Latimer 1910; Forbes and Richardson 1920; Gale and Mohr 1976, as cited in Fuiman 1979; Greeley 1929; Meek and Hildebrand 1910; ODNR, undated; Scott 1967; Scott and Crossman 1973; Trautman 1957; Trautman and Gartman 1974.

LONGNOSE SUCKER

MIGRATION OF ADULTS

Prespawning: Migrate inshore and ascend tributaries in March or April shortly after ice breakup.

Postspawning: Return to deeper water after spawning.

SPAWNING

Season: Late March-July at 36-59°F.

Site: Current-swept areas on lakeshores, beaches, and shoals and in streams and lower reaches of rivers.

Substrate: Eggs are broadcast over gravel or sand.

Water Depth: To 25 ft; as shallow as 6-12 in.[1]

INCUBATION AND HATCHING

Site: Eggs incubate among gravel.

Duration: Eggs hatch in 1-2 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in gravel for 1-2 weeks[1] and then drift downstream to stream mouths, harbors, and shorelines, or offshore.

Substrate: Sand.

Water Depth: Shallow[2]; no specific information.

REFERENCES

Dymond 1926; Eddy and Underhill 1974; Fuiman and Witman 1979; Galloway and Kevern 1976; Geen et al. 1966[1]; Hayes 1967[2]; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Smith 1969; Surber 1920.

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[1] British Columbia

[2] Colorado

WHITE SUCKER

MIGRATION OF ADULTS

Prespawning: Ascend tributaries soon after ice breakup, beginning as early as late March at 38°F; run may occur under the ice.

Postspawning: Usually spend only a few days in stream and return to lake after spawning; some may take up temporary residence in deep stream pools before returning to lake.

SPAWNING

Season: February-early July at 43-74°F; usually April and May at 50-68°F.

Site: Riffles of clean streams, with velocity of 1.6-2.0 fps, or stream pools if water level is low; also lake shoals, beaches, or river mouths with sufficient current.

Substrate: Eggs are broadcast over clean gravel, rock, rubble, or sand, usually with no vegetation.

Water Depth: 4 in. - 4 ft.

INCUBATION AND HATCHING

Site: Eggs are usually buried in gravel and incubate at spawning site; some may drift downstream and collect in pools.

Duration: 5-15 days at 60-50°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in gravel about 2 weeks[1/]; soon after emergence, fry move downstream and are found in protected water along lake shores, in marshes, bays, and harbors; may also spend several months in streams before moving downstream.

Substrate: Gravel for prolarvae; sand and rock for young-of-the-year (YOY) until they are 1-3 in. long; dense vegetation for larger YOY.

Water Depth: To 20 ft.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Anthony and Jorgensen 1977; Buller 1927; Cahn 1927; Carbine 1943; Curry and Spacie 1979; Dymond 1926; Eaton 1928; Eddy and Underhill 1974; Embody 1915, 1922; Faber 1963, 1967; Fish 1929; Forbes and Richardson 1920; Forney 1956; Fuiman 1979; Galloway and Kevern 1976; Geen et al. 1966[1/]; Greeley

1928; Greeley and Bishop 1932; Hankinson 1908, 1913, 1919, 1932; Hedges and Ball 1953; Hubbs and Creaser 1924; Johnson, C., 1971; Lagler 1948; MacKay 1959a, 1969; Olson and Scidmore 1962; Price and Kelly 1976; Raney 1943, 1959; Raney and Webster 1942; Reighard 1913, 1915, 1920; Schneberger 1972b; Scott 1967; Shetter 1938a; Slastenenko 1958; Smith 1969; Spoor 1938; Stewart 1926; Surber 1920, 1940; Trautman 1957; UPI 1979; Werner 1979; Wickliff 1936.

1/ British Columbia

CREEK CHUBSUCKER

MIGRATION OF ADULTS

Prespawning: Move along shorelines; may move upstream in creeks[1].

Postspawning: Migrate downstream to larger waters after spawning.

SPAWNING

Season: Late April and May at 59-72°F.

Site: River mouths or pools, with velocity of 0.3-0.8 fps.

Substrate: Eggs are deposited in a small cleared depression in fine gravel, sand, or mud.

Water Depth: 1 to 2-1/2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate at spawning site.

Duration: Eggs hatch in 4 days at 63-73°F[2].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are abundant in marshes[1] and small streams[3].

Substrate: No information.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928[1]; Carnes 1958[2], as cited in Jones et al. 1978; Curry and Spacie 1979; Forbes and Richardson 1920[1]; Fuiman 1979; Hankinson 1919[1]; Richardson 1913a[1]; Smith 1963; Trautman 1957; Surber and Friddle 1946[3].

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[1] *Erimyzon sucetta oblongus*; probably creek chubsucker

[2] North Carolina

[3] West Virginia

LAKE CHUBSUCKER

MIGRATION OF ADULTS

Prespawning: Migrate into bays and lower reaches of rivers.

Postspawning: No information.

SPAWNING

Season: Late March to mid-July.

Site: Bays, lower reaches of tributaries, ponds, and marshes.

Substrate: Eggs are scattered over beds of rooted aquatic vegetation, filamentous algae, or dead grass.

Water Depth: Shallow; no specific information.

INCUBATION AND HATCHING

Site: Eggs incubate among vegetation.

Duration: 6-7 days at 85-72°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are abundant in marshes and lagoons.

Substrate: Vegetation, mud.

Water Depth: Shallow; no specific information.

REFERENCES

Bennett and Childers 1966; Cooper 1935, 1938; Meek and Hildebrand 1910; ODNR, undated.

NORTHERN HOG SUCKER

MIGRATION OF ADULTS

Prespawning: Ascend creeks from larger, deeper waters, beginning in late March at 40°F.

Postspawning: Return downstream after spawning.

SPAWNING

Season: April and May at 57-66°F.

Site: Fast-water areas, with velocity of 1.3-1.8 fps, at the head of creek riffles.

Substrate: Eggs are scattered over coarse gravel and sand.

Water Depth: 4-18 in.

INCUBATION AND HATCHING

Site: Eggs are buried and incubate under gravel.

Duration: Eggs hatch in 10 days at 63°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in gravel for about 8 days; young-of-the-year are found in warm tributaries and along lake shores near stream mouths.

Substrate: No information.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Buynak and Mohr 1978; Currie and Spacie 1979; Eddy and Underhill 1974; Fuiman 1979; Gerking 1953; Hankinson 1919, 1932; Meek and Hildebrand 1910; Meyer 1967; Raney and Lachner 1946; Reighard 1920; Trautman 1957.

BIGMOUTH BUFFALO

MIGRATION OF ADULTS

Prespawning: Move inshore during spring flooding[1,2,3,4]; also ascend tributaries.

Postspawning: No information.

SPAWNING

Season: Late March to mid-July at 56[1] - 68°F[4].

Site: Bays, marshes, sloughs, backwaters, creek mouths, tributaries, small ditches.

Substrate: Eggs are scattered over vegetation or debris on mud, gravel, or rock.

Water Depth: To 12 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on vegetation or debris; some may sink to the bottom[1,3].

Duration: Eggs hatch in 9-10 days at 62°F[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae rise immediately to surface[1]; young-of-the-year are common in sloughs and backwaters.

Substrate: Mud, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Becker 1976; Canfield 1922[1]; Eddy and Underhill 1974; Forbes and Richardson 1920; Garman 1889; Johnson, R., 1963[2]; June 1977[3]; ODNR, undated; Richardson 1913a; Surber 1920; Walburg and Nelson 1966.

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[1] Iowa

[2] Saskatchewan

[3,4] South Dakota

SILVER REDHORSE

MIGRATION OF ADULTS

Prespawning: Ascend rivers at ice-out, usually in April.

Postspawning: Return to lake after spawning; may remain in harbors throughout the summer.

SPAWNING

Season: April-late June, beginning at 50-56°F[1].

Site: Riffles[1] in rivers and streams, usually in main channels; also shoals in harbors.

Substrate: Eggs are deposited on gravel, rock[1], or rubble[2].

Water Depth: 1-3 ft[2].

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae drift downstream to harbors and river mouths; some young-of-the-year remain in tributaries in slow-water areas near overhanging banks[2].

Substrate: Soft bottom[2].

Water Depth: No information.

REFERENCES

Balon 1975; Curry and Spacie 1979; Galloway and Kevern 1976; Hackney et al. 1971[1]; Jenkins 1970; Meyer 1962[2]; Scott and Crossman 1973.

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[1] Alabama

[2] Iowa

BLACK REDHORSE

MIGRATION OF ADULTS

Prespawning: Enter rivers; river residents move upstream or downstream to spawning site[1].

Postspawning: Females return to deep pools; males return to respective territories[1].

SPAWNING

Season: Late April[1] to mid-May at 56-72°F[1].

Site: Riffles in clean rivers.

Substrate: Eggs are scattered over fine rubble, coarse gravel, or sand[1].

Water Depth: To 2 ft[1].

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in quiet pools, backwaters, and lower reaches of rivers; may also be found in quiet water upstream from spawning site[1].

Substrate: Beds of water willow[1].

Water Depth: No information.

REFERENCES

Balon 1975; Bowman 1970[1]; Curry and Spacie 1979; Trautman 1957.

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[1] Missouri

GOLDEN REDHORSE

MIGRATION OF ADULTS

Prespawning: Enter rivers and smaller streams.

Postspawning: Return to lake in May-July.

SPAWNING

Season: April-early June at 59-72°F.

Site: Fast-water areas, with velocity of 1.3-3.0 fps, in or just above riffles in rivers and streams; may spawn in main stream or smaller tributaries, but avoid high gradient streams.

Substrate: Eggs are deposited on large gravel, possibly in small depressions.

Water Depth: Less than 6 in. - 3 ft[1/].

INCUBATION AND HATCHING

Site: Eggs incubate on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in slow-water areas of streams near overhanging banks[1/], in backwaters, lower reaches of rivers, and river mouths.

Substrate: Soft bottom[1/].

Water Depth: No information.

REFERENCES

Balon 1975; Becker 1976; Curry and Spacie 1979; Eddy and Underhill 1974; Fuiman and Witman 1979; Galloway and Kevern 1976; Gerking 1953; Hankinson 1932; Meyer 1962[1/]; Trautman 1957.

[1/] Iowa

SHORTHEAD REDHORSE

MIGRATION OF ADULTS

Prespawning: Migrate from lakes into larger tributaries usually in April before ice-out.

Postspawning: Return to lake by mid-May; may remain in harbors all summer.

SPAWNING

Season: April-June, usually at 52-70°F; spawning has been reported at water temperatures less than 52°F.

Site: Fast-water areas, with velocity of 2-3 fps, in tributaries more than 30-40 ft wide; also shoals in harbors.

Substrate: Eggs are scattered in small groups over wide area of clean medium-sized gravel and sand.

Water Depth: 6 in. - 3 ft[1].

INCUBATION AND HATCHING

Site: Nonadhesive eggs settle among gravel and rocks.

Duration: Eggs hatch in 8 days at 60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain on bottom for about 5 days, then drift downsteam to harbors or other sheltered areas; young-of-the-year may also remain in fast-water areas of rivers[1] or ascend smaller creeks.

Substrate: Gravel for prolarvae.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Burr and Morris 1977; Buynak and Mohr 1979a; Crossman 1976; Curry and Spacie 1979; Dymond 1926; Eddy and Underhill 1974; Forbes and Richardson 1920; Galloway and Kevern 1976; Hay 1894; Hankinson 1919; Meyer 1962[1]; Parker et al. 1899; Reighard 1920; Slastenenko 1958; Surber 1920.

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[1] Iowa

GREATER REDHORSE

MIGRATION OF ADULTS

Prespawning: Ascend rivers.

Postspawning: No information.

SPAWNING

Season: April-early July at 62-66°F.

Site: River channels and rapids.

Substrate: Eggs are deposited among boulders.

Water Depth: 10 ft.

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year spend the first summer in fast-water areas of rivers or sheltered areas downstream.

Substrate: No information.

Water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Becker 1976; Greeley 1929; Meek and Hildebrand 1910; Slastenenko 1958.

BLACK BULLHEAD

MIGRATION OF ADULTS

Prespawning: Move inshore and into rivers, usually beginning in early May at about 52°F.

Postspawning: Adults guard nest and fry, then presumably return to lakes.

SPAWNING

Season: April-August, usually late May to mid-July at 53-77°F.

Site: Wetlands along lake margins, sheltered bays and harbors, lower reaches of rivers with overhanging banks and abundant deadfall.

Substrate: Eggs are deposited in natural depressions or nests scooped out in sand or mud among abundant vegetation; also among rocks on harbor breakwalls or in muskrat burrows.

Water Depth: 1-3 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate in nest or to vegetation or debris.

Duration: Eggs hatch in 5-7 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest up to 12 days; adults herd fry, until they are about 1 in. long[1], in dense schools near the surface along vegetated shorelines; older young-of-the-year are found in protected areas, such as sloughs, marshes, bays, and lower rivers.

Substrate: Vegetation, mud, sand, silt.

Water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Cahn 1927; Eddy and Underhill 1974; Forbes and Richardson 1920; Fowler 1917; Forney 1955[1]; Garman 1889; Olson 1970, 1971, 1972, 1978; ODNR, undated; Olson and Koopman 1976; Osburn and Williamson 1898; Richardson 1913a; Slastenenko 1958; Smith and Moe 1944.

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[1] Iowa

YELLOW BULLHEAD

MIGRATION OF ADULTS

Prespawning: Move inshore and into bays.

Postspawning: Adults guard nest and fry and then return to lakes.

SPAWNING

Season: A 2-week period in May or June.

Site: Weed beds and lagoons in lakes, under overhanging banks in rivers, or at entrance of deserted muskrat burrows.

Substrate: Eggs are deposited in depression or burrow hollowed out in soft bottom of mud and heavy vegetation, usually beside or under banks, logs, or tree roots; also deposited on boards or other debris.

Water Depth: 1[1] - 4 ft.

INCUBATION AND HATCHING

Site: Eggs are often attached to small roots in nest.

Duration: Eggs hatch in 5-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Until they are about 2 in. long, fry remain in large schools in quiet water; adults guard these schools; older young-of-the-year are found near spawning grounds, in protected waters such as bays and marshes; also in small creeks.

Substrate: Vegetation, mud, sand, silt.

Water Depth: To 6 ft.

REFERENCES

Adams and Hankinson 1928; Aitken 1936[1]; Cahn 1927; Eddy and Underhill 1974; Forbes and Richardson 1920; Fowler 1917; Hankinson 1913; Langlois 1954; McCrimmon 1956; ODNR, undated; Richardson 1913a; Scott 1967; Slastenenko 1958.

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[1] Iowa

BROWN BULLHEAD

MIGRATION OF ADULTS

Prespawning: Move inshore and into rivers, beginning in early April at 50-55°F.

Postspawning: Adults guard nest and fry and then return to lake in summer and fall.

SPAWNING

Season: April-August, usually June or July, at 62-72°F; spawning may occur twice a year.

Site: Marshes in bays, harbors, coves, creek mouths, and lower reaches of creeks; also rivers with overhanging banks and abundant deadfall.

Substrate: Eggs are deposited in depression or burrow made in mud, sand, or clay under logs and roots; nest is excavated down to firm bottom of stones, gravel, or coarse sand; nests also made on breakwalls, in muskrat burrows, or in debris, including cans, tires, or stumps.

Water Depth: 3 in. - 5 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate in bottom of nest, often attached to exposed fibrous roots.

Duration: Eggs hatch in 5-20 days at 77°F[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest up to 12 days; adults guard fry in weedy shallows for 2-3 weeks; older young-of-the-year (YOY) remain in protected vegetated areas near spawning grounds; some YOY move downstream from river marshes during the summer.

Substrate: Vegetation, sand, mud, gravel, rock.

Water Depth: 1-18 in.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Armstrong 1962; Becker 1976; Breder 1935; Buller 1927; Calhoun and Coon 1941; Eddy and Underhill 1974; Embody 1922; Eycleschymer 1901; Forbes and Richardson 1920; Fowler 1917; Greeley 1928; Hankinson 1908; MacKay 1957d, 1969;

McCrimmon 1956; Meek and Hildebrand 1910; Moore 1922; Olson 1972; Raney 1959; Raney and Webster 1940; Reighard 1915; Richardson 1913a; Sibley 1922; Slastenenko 1958; Smith and Harron 1904[1]; Surber 1920; Titcomb 1920, 1922.

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[1] Laboratory study.

CHANNEL CATFISH

MIGRATION OF ADULTS

Prespawning: Move inshore from deep water; may enter and migrate long distances up tributaries.

Postspawning: One or both adults guard nest and fry until they are about 1 in. long, then return to lakes in fall.

SPAWNING

Season: Mid-April to August at 65-85°F[3/]; two spawning peaks may occur[6/].

Site: Nearshore areas, including wetlands, marshes, bays, harbors, and creek mouths; backwaters, pools[4/], and shoals in rivers, especially areas of strong current.

Substrate: Eggs are deposited in nest or burrow made in crevices, hollow logs, undercut banks, or stumps, on bottom of rock, rubble, gravel, mud, sand, clay, or vegetation; also on rock breakwalls.

Water Depth: To 42 ft; usually less than 12 ft.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates on bottom of nest[1,5/].

Duration: Eggs hatch in 5 days at 72-82°F and in 10 days at 60°F[1,2,3,5,7/].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest up to 8 days[6/]; young-of-the-year are abundant on shoals in small creeks; apparently move downstream to bays, harbors, creek mouths and protected marshes, beaches, and shorelines.

Substrate: Rock, gravel, vegetation, mud; also in crevices between rocks in diking.

Water Depth: To 15 ft in early summer; to 58 ft by August.

REFERENCES

Adams and Hankinson 1928; Calhoun and Coon 1941; Canfield 1947[1/]; Clapp 1929[2/]; Clemens and Sneed 1957[3/]; Doze 1925[4/]; Eddy and Underhill 1974; Forbes and Richardson 1920; Garman 1889; Greeley 1928; Jordan 1885a; Lenz 1947[5/]; MacKay 1969; Marzolf 1957[6/]; McCormick 1892; Price and Kelly 1976; Raphael and Jaworski 1979;

Scott 1967; Scott and Crossman 1973; Shira 1917[7], Slastenenko 1958; Smith 1969; Surber 1920; Trautman 1957; USDI 1969b.

[1,2,5,6] Hatchery data

[3,7] Laboratory study

[4] Kansas

STONECAT

MIGRATION OF ADULTS

Prespawning: Short movement inshore; may ascend creeks.

Postspawning: Adults guard eggs and fry until fry leave nest.

SPAWNING

Season: Early June-late August; spawning usually peaks last 2 weeks in June.

Site: Sheltered shoreline areas, bays, creek mouths, lake reefs, and lower riffles in rivers.

Substrate: Eggs are deposited in nest dug underneath flat objects, such as boards, stones, or logs, on gravel, rock, or boulder bottom with no vegetation.

Water Depth: 1-42 ft.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates in nest.

Duration: Eggs hatch in about 2 weeks, beginning in mid-June.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest for several days; young-of-the-year (YOY) are found under stones, on riffles, in sheltered nearshore areas and creek mouths; YOY may migrate downstream to lakes.

Substrate: Sand and gravel with sparse vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Eddy and Underhill 1974; Eigenmann 1896; Forbes and Richardson 1920; Greeley 1934; Meek and Hildebrand 1910; Slastenenko 1958; Taylor 1969; Trautman 1957.

TADPOLE MADTOM

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male guards nest and fry.

SPAWNING

Season: May-August.

Site: Quiet areas along lake shores, in bays, harbors, and low-gradient streams.

Substrate: Eggs are deposited in nest made under boards, logs, or tree roots, in cans or crayfish burrows, on bottom of mud, organic debris, marl, or vegetation.

Water Depth: 3 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in nest.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in protected nearshore areas, including marshes.

Substrate: Sand, mud, silt, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Allen 1914; Cahn 1927; Evermann and Clark 1920; Forbes and Richardson 1920; Hankinson 1908; ODNR, undated; Richardson 1913a; Slastenenko 1958; Taylor 1969; Trautman 1948.

BRINDLED MADTOM

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male guards nest and fry.

SPAWNING

Season: May-early August at about 78°F.

Site: Lakeshores, beaches, and reefs; in pools and riffles in low-gradient streams.

Substrate: Eggs are deposited in nest made under boulders, rocks, logs or in discarded cans, on bottom of rock, gravel, boulders, mud, or silt, with vegetation and debris, including fallen trees and roots.

Water Depth: Shallow; no specific information.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates in nest.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in marshes and tributaries.

Substrate: Sand, mud, silt, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; ODNR, undated; Osburn and Williamson 1898; Taylor 1955, 1969; Trautman 1948.

FLATHEAD CATFISH

MIGRATION OF ADULTS

Prespawning: Migrate from lakes into rivers.

Postspawning: Male guards eggs.

SPAWNING

Season: Late June[2] - August.

Site: Large rivers and river mouths, especially under overhanging banks.

Substrate: Eggs are deposited in nest dug in gravel or on cleaned areas of rocks.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates in nest.

Duration: Eggs hatch in 6 or 7 days at 75-82°F[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry are carried from nest to swift riffles where they remain until 2-4 in. long, then spread out to other areas of stream[2].

Substrate: Rubble.

Water Depth: No information.

REFERENCES

Balon 1975; Guidice 1965[1]; Lagler 1948; Minckley and Deacon 1959[2].

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[1] Hatchery data

[2] Kansas

TROUT-PERCH

MIGRATION OF ADULTS

Prespawning: Migrate from depths greater than 210 ft to nearshore areas or into tributaries, usually beginning as early as April.

Postspawning: Return to lakes by late September or October.

SPAWNING

Season: A 2-1/2 month period in mid-March to late September at 40[1] - 70°F; most spawning occurs in June-August at 67-68°F; two peaks of spawning may occur.

Site: Quiet nearshore areas, including beaches, shoals, harbors, sloughs, and river mouths, with a slight current near surface; also on riffles in swift streams.

Substrate: Eggs are scattered at random near surface over sand, gravel, rubble, mud, silt[1], and vegetation.

Water Depth: 2[1] - 125 ft.

INCUBATION AND HATCHING

Site: Eggs settle to bottom and fall between rocks or adhere to vegetation or other substrate.

Duration: Eggs hatch in 6-7 days at 68-73°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae develop on spawning substrate; young-of-the-year (YOY) remain inshore near spawning grounds, on beaches, in river mouths, harbors, and bays, until late summer and then move offshore.

Substrate: Sand, gravel, mud.

Water Depth: Most YOY are found near bottom in less than 30 ft of water; in late summer they move offshore to deeper water.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Butler 1962; Dymond 1926; Eddy and Underhill 1974; Fish 1929; Forbes and Richardson 1920; Hubbs and Lagler 1958; Lawler 1954[1]; Magnuson and Smith 1963; ODNR, undated; Price and Kelly 1976; Priegel 1962; Reed and Wright 1909; Reighard 1915; Scott and Crossman 1973; Slastenenko 1958.

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[1] Manitoba

BURBOT

MIGRATION OF ADULTS

Prespawning: Move from deep water to nearshore areas and into harbors and rivers, usually beginning in early November.

Postspawning: Usually return to deeper water by April; may remain in harbors until mid-June before moving into lakes; often move from lakes into rivers after spawning.

SPAWNING

Season: A 1-week period in November-May, at 33-50°F; varies considerably with locality; eggs have also been collected in September.

Site: Nearshore areas, including shorelines, river mouths, bays, and harbors; offshore bars and reefs; swift, open water in streams.

Substrate: Eggs are scattered in mid-water over rock, gravel, shale, sand, clay, or mud.

Water Depth: 1-480 ft; both deepwater and shallow-water spawners are reported.

INCUBATION AND HATCHING

Site: Nonadhesive[2], semibuoyant eggs settle to bottom in quiet water; may be carried from spawning site by slight current.

Duration: Eggs hatch in 30 days at 43°F[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae are found along shores, in harbors, bays, river mouths, and tributaries; older young-of-the-year (YOY) disperse throughout surface waters in mid-lake.

Substrate: Sand[2], gravel[3], shale, rock, some vegetation.

Water Depth: Less than 1 ft[3] - 200 ft; larvae hatched in deeper water may move to shallows; older YOY move to deeper water.

REFERENCES

Adams and Hankinson 1928; Bean 1884a, 1903; Becker 1976; Bjorn 1939[1]; Cahn 1936; Dymond 1926; Eddy and Underhill 1974; Eaton 1928; Faber 1963, 1967; MacKay 1957a, 1969; McCrimmon 1956, 1959; McCrimmon and Devitt 1954; Miller 1970a[2], b[3]; Noble 1968; Reighard 1915; Robins and Deubler 1955; Scott 1967; Scott and Crossman 1973; Smith and Moe 1944; Weber 1971.

[1,2,3] Wyoming

BANDED KILLIFISH

MIGRATION OF ADULTS

Prespawning: Little movement.

Postspawning: Little movement.

SPAWNING

Season: May-August at 70[1] - 90°F[2].

Site: Quiet areas; including bays, harbors, creek mouths, and lagoons; also moderately swift streams.

Substrate: Eggs are scattered over sand, gravel, rubble, emergent vegetation, and filamentous algae.

Water Depth: 6-8 in.[2]

INCUBATION AND HATCHING

Site: Eggs have adhesive filaments which hold them in place in masses of filamentous algae or on other vegetation.

Duration: Eggs hatch in 9-12 days at 72-80°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year remain in sheltered areas in or near spawning site, including beaches, marshes, and lagoons.

Substrate: Sand, gravel, vegetation [2].

Water Depth: Less than 1 in.[2] - 20 ft.

REFERENCES

Adams and Hankinson 1928; Cahn 1927; Cooper 1935, 1938; Eddy and Underhill 1974; Eigenmann 1896; Evermann and Clark 1920; Fish 1929; Forbes and Richardson 1920; Foster 1967; Fowler 1922; Greeley 1928, 1935; Langlois 1954; Osburn and Williamson 1898; Price and Kelly 1976; Richardson 1939[1]; Scott 1967; Webster 1941[2].

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[1] Quebec

[2] Connecticut

BROOK SILVERSIDE

MIGRATION OF ADULTS

Prespawning: Move inshore from deep water.

Postspawning: No information.

SPAWNING

Season: Mid-April to early August at 68-73°F; peak spawning usually occurs in late May or early June.

Site: Protected lake shorelines, shoals, bays, river mouths, and marshes; also areas of moderate current in rivers.

Substrate: Eggs are scattered in mid-water over sand, gravel, and vegetation.

Water Depth: 1-3 ft.

INCUBATION AND HATCHING

Site: Eggs settle to bottom and attach to substrate or vegetation by adhesive filament.

Duration: Eggs hatch in 8-9 days at 73°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae are found in pelagic areas along shores and beaches and in marshes, bays, and river mouths; older young-of-the-year (YOY) are found in mid-lake.

Substrate: Sand, rock, gravel, clay, mud; if vegetation is present, YOY are found in open water between clumps of plants.

Water Depth: Newly hatched larvae are found near surface at depths to 4 ft; they soon move to depths of 33-66 ft where they are found in the upper few inches of water; YOY return to shallow water in late summer.

REFERENCES

Adams and Hankinson 1928; Bensley 1915; Breder 1962; Cahn 1927; Eddy and Underhill 1974; Hubbs 1921; Hubbs and Lagler 1958; Langlois 1954; Nelson 1968a; Price and Kelly 1976; Richardson 1913a; Zimmerman 1970.

BROOK STICKLEBACK

MIGRATION OF ADULTS

Prespawning: Move from deeper overwintering areas to shallow areas, just after ice breakup[1].

Postspawning: Male guards nest and fry, then gradually moves downstream to deeper water; a large downstream migration may occur.

SPAWNING

Season: April to mid-July at 40-74°F; may spawn twice a season.

Site: Margins of ponds and stream pools, in concealed locations, including overhanging banks; also where meltwater runoff enters streams[1].

Substrate: Eggs are deposited in nest built on vegetation or gravel and attached to grass, rootlets, stems, sticks, or vertical surfaces of rocks.

Water Depth: May nest at any level in water column in water up to 1 ft deep.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate in nest, constructed of algae, dead grass, small twigs, or organic debris held together by secretions of the male.

Duration: Eggs hatch in 7-10 days at 65-61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae hang from vegetation in nest; male constructs nursery of old nest materials above or adjacent to nest, in which he restrains fry after they rise from nest; after a couple days, fry leave nursery but remain in vegetated areas.

Substrate: Vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Applegate 1961; Braekevelt and McMillan 1967; Cahn 1927; Eddy and Underhill 1974; Faber 1963; Greeley 1934; Harkness and Ricker 1929; Jacobs 1948; Lamsa 1963a; Langlois 1954; MacLean and Gee 1971[1]; McKenzie 1974; Manion 1977; Nelson 1968; Price and Kelly 1976; Reisman and Cade 1967; Scott 1967; Slastenenko 1958; Wooton 1976.

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[1] Manitoba

THREESPINE STICKLEBACK

MIGRATION OF ADULTS

Prespawning: Move from deeper water to nearshore areas, creek mouths, and bays, and often ascend tributaries.

Postspawning: Male guards nest and newly hatched fry for maximum of 9 days[4] and then begins return to deeper water[1].

SPAWNING

Season: April-September at 50[4] - 73°F[3]; several spawnings may occur each season.

Site: Sheltered, current-free[3] areas along lake shores[2] and in bays, creek mouths, and tributaries, usually close to shore[3].

Substrate: Eggs are deposited in nest built on mud[3,4], sand, vegetation, or flat surface of a rock[5]; also scattered onto vegetation[2].

Water Depth: About 10 in. but as shallow as 1-2 in.[3]

INCUBATION AND HATCHING

Site: Adhesive masses of eggs incubate in nest constructed of sand grains and plant fragments held together by secretions of the male.

Duration: Eggs hatch in 4-27 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry leave nest about 1-2 weeks after hatching; young-of-the-year are found in protected coves, river mouths, and marshes.

Substrate: Vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Bean 1903; Bigelow and Schroeder 1953[1]; Greenbank and Nelson 1959[2]; Fish 1932; Hagen 1967[3]; Kynard 1978[4]; Nash 1913; Scott 1967; Seal 1892[5]; Slastenenko 1958; Wooton 1976.

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[1] Gulf of Maine

[2] Alaska

[3] British Columbia

[4] Washington

[5] Laboratory study

NINESPINE STICKLEBACK

MIGRATION OF ADULTS

Prespawning: Move inshore to shoals and harbors or upstream into creeks.

Postspawning: Male guards nest and fry.

SPAWNING

Season: May-July at 49-62°F; peak spawning occurs at 52-54°F[1]; may spawn more than once a season.

Site: Quiet areas in vegetated bays and creeks, 1-5 ft from shore; may also spawn along exposed shoreline but this is not as successful.

Substrate: Eggs are deposited in nest built on vegetation, rock, or rubble, or in highly organic mud or sand.

Water Depth: To 144 ft, but usually less than 60 ft; usually nests 1-8 in. above substrate.

INCUBATION AND HATCHING

Site: Eggs incubate in nest constructed of fine plant fragments held together by secretions of the male.

Duration: Eggs hatch in 9 days or less; in 4 or 5 days at 64-66°F

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Male may construct nursery of plant fragments; nursery is located above the nest and contains young fry; when fry are about 2 weeks old and 0.5 in. long, they scatter into vegetation; older young-of-the-year (YOY) hide among rocks nearshore.

Substrate: Rock, vegetation.

Water Depth: To 30 ft; older YOY may move to deeper water.

REFERENCES

Dymond 1926; Dymond et al. 1929; Griswold and Smith 1972[1]; Morris 1958; Nelson 1968b; Price and Kelly 1976; Scott and Crossman 1973; Wooton 1976.

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[1] Laboratory study

WHITE PERCH

MIGRATION OF ADULTS

Prespawning: Move inshore and enter tributaries usually beginning in April.

Postspawning: Return downstream after spawning[5].

SPAWNING

Season: A period of 1-3[3] weeks in April-early July at 50-73°F; eggs have been found as late as September.

Site: Nearshore reefs and shoals, bays, or tributaries.

Substrate: Eggs are scattered at random in open water over almost any substrate[3], including fine gravel[4], rock, muck[1], or submerged vegetation.

Water Depth: To 12 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rocks or vegetation.

Duration: 30 hours at 68°F - 6 days at 52°F[2].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae sink to bottom[6]; larvae become pelagic and are carried by currents[1]; young-of-the-year are found in quiet water along shore and in bays and also on current-swept shoals.

Substrate: Sand, clay, gravel, pulverized snail shells, mud[7], or vegetation.

Water Depth: To 12 ft[7].

REFERENCES

Auclair 1956[1]; Bigelow and Schroeder 1953[2]; Christie and Regier 1973; Foster 1919[3]; Hoover 1937[4]; Lagler 1948; Mansueti 1961[5], 1964[6]; Raney 1959; Richards 1960; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Toman 1955; Webster 1941[7].

1,3/ Maine

2/ Gulf of Maine

4/ New Hampshire

5,6/ Chesapeake Bay

7/ Connecticut

WHITE BASS

MIGRATION OF ADULTS

Prespawning: Move inshore from deep water and enter tributaries, beginning in April at about 55°F; often move many miles upstream.

Postspawning: Return to lakes or deeper water in rivers after spawning.

SPAWNING

Season: A period of 5-10 days in April-early July, usually late May-early June, at 55-79°F.

Site: Clear, swift tributaries; if tributaries are not available, will spawn on current-swept lake shores or shoals or in bays.

Substrate: Eggs are scattered at random at surface or in mid-water usually over firm bottom of rock, gravel, rubble, sand, or clay; occasionally over mud; abundant vegetation may be present.

Water Depth: To 36 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rocks or vegetation; in flowing water, eggs may be carried a short distance from spawning site.

Duration: Eggs hatch in 46 hours at 60°F[2].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Most prolarvae are carried downstream to bays and harbors; young-of-the-year remain in littoral areas along shore, including bays, harbors, marshes, river mouths, and along exposed shoreline.

Substrate: Rock, rubble, gravel, sand, hard clay, and muck with some submerged vegetation; usually avoid dense weed beds and organic substrate[1].

Water Depth: Usually more than 6 ft; greatest densities have occurred in 6-12 ft of water.

REFERENCES

Adams and Hankinson 1928; Baily and Harrison 1945[1]; Bean 1902, 1903, 1913; Cahn 1927; Calhoun and Coon 1941; Eddy and Underhill 1974; FWS 1945; Garman 1889; Hassler et al. 1958; Horrall 1961; Hubbs and Eschmeyer 1938; Hubbs and Lagler 1958; Lagler 1948; MacKay 1958c, 1969; MSBFC 1893[2]; Nash 1913; Pell 1859; Riggs 1955; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith 1969; Trautman 1957; USDI 1966, 1969b; Wickliff 1934, 1936, 1957.

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[1] Iowa

[2] Laboratory study

ROCK BASS

MIGRATION OF ADULTS

Prespawning: Move inshore beginning at 55°F; often move many miles along shore to reach bays and creek mouths; stream residents congregate in pools just before spawning.

Postspawning: Male guards nest and newly hatched fry; lake residents then return to lake.

SPAWNING

Season: April-early August, usually late May-June, at 57-75°F.

Site: Sheltered nearshore areas, including bays, harbors, lagoons, marshes, creek mouths, and lower reaches of tributaries; current-swept lake shoals and ledges; moderate-swift water in streams; inconspicuous nest is usually in shaded site, next to or under a log, rock, or other shelter.

Substrate: Eggs are deposited in shallow depression excavated in gravel, rock, sand, mud, clay, marl, or vegetation to expose fibrous plant rootlets; may nest on rock breakwalls or spawn over nests of other centrarchids.

Water Depth: To 20 ft; usually less than 6 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rootlets or vegetation in nest.

Duration: Eggs hatch in 3-4 days at 69-70°F[1] or 10-12 days at 60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in nest 2-3 days; after leaving nest, young remain near littoral spawning grounds, in weed beds, bays, harbors, marshes, and on shoals and beaches.

Substrate: Dense vegetation and rubble, gravel, rock, or mud.

Water Depth: To 10 ft; some may assume pelagic existence.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1902, 1903; Breder 1936[1]; Cahn 1927; Calhoun and Coon 1941; Carbine 1939; Crossman 1976; Eddy and Underhill 1974; Embody 1915; Ernest 1960; Evermann and Clark 1920; Faber 1963, 1967; Forbes and Richardson 1920; Fowler 1923; Greeley 1928; Hankinson 1908; Hile 1941; Hubbs and Eschmeyer 1938; Johnson

and Hale 1970; Lagler 1948; MacKay 1958d, 1969; McCrimmon 1956; Nichols 1954; Osburn and Williamson 1898; Parker et al. 1899; Pell 1859; Price and Kelly 1976; Reighard 1915; Schneberger 1973; Scott 1967; Skille 1968; Slastenenko 1958; Smith and Moe 1944; Surber 1920; Trautman 1957; U.S. Comm. Fish Fish. 1900.

1/ Laboratory study

GREEN SUNFISH

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male guards nest and newly hatched fry.

SPAWNING

Season: Mid-May to late August at 68-82°F; peaks in June; possibly several spawnings at intervals of 8-9 days.

Site: Sheltered nearshore areas, including lagoons, harbors, lower reaches of rivers, and quiet waters of streams; nesting sites are usually unshaded and within 6 ft of shore.

Substrate: Eggs are deposited in shallow excavation made in sand, stones, gravel, or marl; also in mud or muck, where excavation reaches firm bottom; nest is often in exposed site, among dense vegetation, next to a log or rock; may spawn on rock breakwalls or in abandoned nests of other species.

Water Depth: To 15 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rootlets, gravel, or lumps of clay in bottom of nest.

Duration: Eggs hatch in 9 days or less; in 50 hours at 75°F[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in lower reaches of rivers, harbors, and marshy lagoons.

Substrate: Mud, vegetation.

Water Depth: 1-7 ft.

REFERENCES

Cahn 1927; Childers 1967[1]; Crossman 1976; Eddy and Underhill 1974; Forbes and Richardson 1920; Hankinson 1908, 1919; Hubbs and Cooper 1935; Hunter 1963; Lagler 1948; Osburn and Williamson 1898; Parker et al. 1899; Slastenenko 1958; Taylor 1978.

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[1] Laboratory study

PUMPKINSEED

MIGRATION OF ADULTS

Prespawning: Move short distances inshore and enter creeks.

Postspawning: Male guards nest and newly hatched fry.

SPAWNING

Season: May-August, beginning at 55°F; occurs at water temperatures as high as 84°F[1].

Site: Quiet nearshore areas, including bays, harbors, marshes, lagoons, backwaters, and creek mouths; also running waters of tributaries.

Substrate: Eggs are deposited in conspicuous depression made in sand, gravel, or marl, or in mud or detritus excavated to expose coarse gravel or plant roots; nest is always among vegetation; may spawn over nests of other centrarchids.

Water Depth: 3 in.[1] - 7 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on gravel, plants, or roots in nest.

Duration: Eggs hatch in 10 days or less; in 3 days at 82°F[2].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry leave nest soon after hatching; young are found near spawning grounds, especially in thick weed beds, in bays, harbors, and lower reaches of rivers; some are found on open shoals.

Substrate: Dense vegetation, sand.

Water Depth: To 6 ft; some may assume a pelagic existence.

REFERENCES

Adams and Hankinson 1916, 1928; Allen 1914; Amundrud et al. 1974; Bean 1902, 1903; Breder 1936[1,2]; Cahn 1927; Carbine 1939; Clark and Keenleyside 1967; Colgan and Ealey 1973; Crossman 1976; Eddy and Underhill 1974; Embody 1915, 1922; Emery 1973; Evermann and Clark 1920; Faber 1963; Forbes and Richardson 1920; Fowler 1923; Gill 1907b; Greeley 1928, 1929; Hankinson 1908; Hubbs 1919; Hubbs and Eschmeyer 1938; Johnson, C., 1971; Keenleyside 1978; Lagler 1948; Langlois 1954; MacKay 1959c, 1969; McCrimmon 1956; Nash 1913; Nichols 1954; Olson and Koopman 1976; Peterka and Kent 1976; Raney and

Lachner 1942; Reed and Wright 1909; Reighard 1913, 1915; Richardson 1913a; Slastenenko 1958; Tayor 1978; Werner 1967; Wickliff 1957.

1/ New Jersey

2/ Laboratory study

ORANGESPOTTED SUNFISH

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Late May-early August beginning at 65°F[1]; ripe adults have been collected at 77°F[2].

Site: Marshy areas of lakes and low-gradient streams; also in harbors.

Substrate: Eggs are deposited in nest made in pebbles or sand or in silt or mud excavated down to solid bottom; may nest on harbor breakwaters.

Water Depth: 1-3 ft[1].

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on pebbles in nest[1].

Duration: Eggs hatch in 5 days at 65-70°F[1].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in the lower reaches of rivers.

Substrate: No information.

Water Depth: No information.

REFERENCES

Barney and Anson 1923[1]; Cross 1950[2]; Forbes and Richardson 1920; Richardson 1913a.

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[1] Iowa

[2] Oklahoma

BLUEGILL

MIGRATION OF ADULTS

Prespawning: Little movement; may move short distance inshore.

Postspawning: Male guards nest until newly hatched fry leave nest; may then remain with fry for a few additional days until they disperse.

SPAWNING

Season: Early May to mid-August at 60-87°F; probably peaks in July.

Site: Quiet nearshore areas of lakes or stream pools, including wetlands, marshes, bays, coves, harbors, lagoons, and creek mouths; nest is usually adjacent to emergent vegetation.

Substrate: Eggs are deposited in nest; nest is a large depression made in sand, gravel, marl, or clay or in mud or detritus excavated down to firm bottom or rootlets; nest is usually among vegetation; may nest on rock breakwalls or spawn over nests of other centrarchids.

Water Depth: To 15 ft; usually less than 5 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on fibrous roots or stones in bottom of nest.

Duration: Eggs hatch in 2-4 days at 76-67°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in nest; fry move into littoral zone after leaving nest; when less than 0.5 in. long, move into limnetic zone for 6-7 weeks; when about 0.8-1.0 in. long, return to littoral zone and remain in dense weed beds in marshes, bays, or lower reaches of rivers for rest of summer.

Substrate: Vegetation.

Water Depth: From the shoreline, at depths of 4-6 in., into the limnetic zone.

REFERENCES

Adams and Hankinson 1928; Amundrud et al. 1974; Beard 1971, 1972; Beyerle 1978; Brass 1938; Calhoun and Coon 1941; Carbine 1939;

Childers 1967; Clark and Keenleyside 1967; Coggeshall 1924; Crossman 1976; Eddy and Underhill 1974; Embody 1915; Evermann and Clark 1920; Faber 1963, 1967; Forbes and Richardson 1920; Hall and Warner 1977; Hankinson 1908; Hubbs 1919; Hubbs and Eschmeyer 1938; Johnson, C., 1971; Lagler 1948; Langlois 1954; Latta 1969; Morgan 1951; Mraz and Cooper 1957; Nichols 1954; Osburn and Williamson 1898; Paxton and Day 1974; Peterka and Kent 1976; Price and Kelly 1976; Raney 1959; Raphael and Jaworski 1979; Reighard 1915; Richardson 1913a,b; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Snow et al. 1960; Stevenson 1966; Storck et al. 1978; Surber 1920; Taylor 1978; Werner 1967; Wickliff 1957.

SMALLMOUTH BASS

MIGRATION OF ADULTS

Prespawning: Migrate inshore and enter bays and tributaries; movement begins when water temperature rises above 40°F; peak movement occurs at 55°F.

Postspawning: Male guards nest and fry until fry are about 1 in. long; adults move downstream or offshore to depths of 36-42 ft as water temperature approaches 77°F, usually by July.

SPAWNING

Season: A period of 6-10 days in March to mid-August, usually May-July, at 51-70°F; nest building may begin at water temperatures below 60°F, but spawning usually does not begin until the water temperature reaches about 62°F.

Site: Clear water in tributaries, river mouths, bays, harbors, lake shores or shoals; nest usually built close to boulders, logs, docks or other such structures; sometimes among rooted macrophytes; in an area with good water movement that is protected from wave action.

Substrate: Eggs are deposited in nest, a shallow depression excavated in cleaned gravel, rock, rubble, or sand; spawning may also occur on harbor breakwalls.

Water Depth: To 20 ft; usually less than 6 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to stones, short stems, or roots on bottom of nest.

Duration: Eggs hatch in 2-15 days at 70-55°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry gradually disperse from nest when 1-2 weeks old and are then found along edges of vegetation beds; young-of-the-year are found in littoral zones of streams, river mouths, bays, harbors, coves, or lake shores, or also on lake shoals; usually near structures.

Substrate: Rock, gravel, rubble, sand, or vegetation; avoid mud.

Water Depth: To 60 ft; usually less than 20 ft; move to deeper water during late summer.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1902, 1903, 1913; Beeman 1924; Brynildson 1965; Cahn 1927; Calhoun and Coon 1941; Clady 1970; Crossman 1976; Dymond 1931; Eaton 1928; Eddy and Underhill 1974; Embody 1915, 1922; Evermann and Clark 1920; Faber 1963, 1967; Fowler 1925; Greeley 1927, 1928; Hay 1894; Holt 1888; Hough 1902; Hubbs and Baily 1938; Johnson and Hale 1970, 1977; Lagler 1948; Langlois 1941; Latta 1975; Lydell 1903; MacKay 1960d, 1969; Marinac 1976; McCrimmon 1956; Meehan 1910; Moore 1922; Mraz 1960, 1964b; Needham 1922; Price and Kelly 1976; Raney 1959; Reighard 1905, 1913, 1915; Robbins and McCrimmon 1977; Schneberger 1972a; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Stockwell 1876; Surber 1920; Tester 1930; Titcomb 1922; Turner 1920b; Turner and MacCrimmon 1970; U.S. Comm. Fish Fish. 1900; USDI 1966, 1969b; Webster 1953.

LARGEMOUTH BASS

MIGRATION OF ADULTS

Prespawning: May move short distances inshore or into marshes.

Postspawning: Little movement from spawning site; male guards nest and fry until fry are about 1 in. long; may move to somewhat deeper water after spawning[1].

SPAWNING

Season: April-August, usually late May-early July, at 58-70°F.

Site: Protected littoral areas in lakes or tributaries, including marshes, bays, harbors, sloughs, lagoons, and creek mouths; nest is usually among vegetation or near structures, such as logs or stumps.

Substrate: Eggs are deposited in a nest made in almost any substrate, including gravel, rock, clay, sand, mud, detritus, or vegetation; soft substrate is excavated down to firm bottom; may spawn over nests of rock bass.

Water Depth: To 15 ft; usually less than 6 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to roots or stones on bottom of nest.

Duration: Eggs hatch in 2-15 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest for 5-10 days, then gradually disperse; young spend the first summer of life in sheltered, littoral, weedy areas near spawning grounds and move offshore in fall.

Substrate: Vegetation, sand, mud, detritus; occasionally stone or rubble.

Water Depth: Usually to 6 ft; also found at depths of 14-20 ft around structures.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1903; Bennett 1954; Cady 1945[1]; Cahn 1927; Clady 1970; Calhoun and Coon 1941; Carbine 1939; Crossman 1976; Eaton 1928; Eddy and Underhill 1974; Embody 1922, 1915; Evermann and Clark 1920; Faber 1963, 1967; Garman 1889; Greeley 1928, 1929; Hamilton and Powles 1979; Hankinson 1908; Hough 1902; Hubbs 1919; Hubbs and Baily 1938; Johnson, C., 1971; Kramer and Smith 1960, 1962; Lagler 1948; Latta 1974; Lydell 1903; MacKay 1960e, 1969; McCrimmon 1956; Mraz 1954, 1964b; Mraz and Cooper 1957; Mraz et al. 1963; Nash 1913; Olson and Koopman 1976; Paxton and Day 1974; Raney 1959; Rathbun and Wakeham 1897; Reighard 1905, 1913, 1915; Richardson 1913a; Scott 1967; Shealy 1971; Slastenenko 1958; Smith et al. 1958; Smith and Moe 1944; Surber 1920; Turner 1920b, USDI 1966, 1969b; U.S. Comm. Fish Fish. 1900; Williamson and Churchill 1948.

1/ Tennessee

WHITE CRAPPIE

MIGRATION OF ADULTS

Prespawning: Migrate inshore and ascend tributaries.

Postspawning: Male guards nest and newly hatched fry; female usually returns to deep water immediately after spawning[2].

SPAWNING

Season: A 1-week period in late March-early July, usually in May-June, at 40°-80°F; spawning peaks at 61-68°F[2].

Site: Clear water, usually with some current, in tributaries, river mouths, harbors, bays, coves, or marshes; nest is usually 2-30 ft from shore and sheltered by ledges, banks, brush, stumps, or vegetation.

Substrate: Eggs are deposited in nest on gravel, hard clay, sand or vegetation, swept clean of debris and silt.

Water Depth: To 20 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on nest bottom or on vegetation a few inches above bottom of nest.

Duration: Eggs hatch in about 24-27 hours at 70-72°F, or 42-103 hours at 73-58°F[2].

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in sheltered areas in lower reaches of rivers, bays, harbors, or lake shorelines; also may avoid shoreline and migrate into open water during summer[1,3,4].

Substrate: Vegetation, mud, sand.

Water Depth: May migrate from shallow shorelines to pelagic zone during summer [1,3,4].

REFERENCES

Cahn 1927; Eddy and Underhill 1974; Forbes and Richardson 1920; Gasaway 1970[1]; Greeley 1929; Hansen 1943, 1951, 1965; Hubbs and Eschmeyer 1938; Lagler 1948; Morgan 1951, 1954; ODNR, undated; Schneberger 1972c; Siefert 1968[2], 1969[3]; Slastenenko 1958; Surber 1920; Taber 1969[4].

[1,2,3] South Dakota

[4] Oklahoma, Texas

BLACK CRAPPIE

MIGRATION OF ADULTS

Prespawning: Move inshore and enter tributaries as early as late March.

Postspawning: Male guards nest and newly hatched fry.

SPAWNING

Season: Late March-August, usually late May-early July, at 61-79°F.

Site: Sheltered nearshore areas, including bays, harbors, marshes, sloughs, lagoons, creek mouths, and lower reaches of rivers; usually near vegetation beds or plant roots.

Substrate: Eggs are deposited in nest excavated in sand, gravel, mud, or vegetation.

Water Depth: To 10 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on vegetation 2-4 in. above nest botton or on roots at bottom of nest.

Duration: Eggs hatch in 3-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found close to spawning grounds in sheltered nearshore areas, including lake shores, bays, creek mouths, and weed beds; may quickly move to open water[1].

Substrate: Mud, sand, silt, vegetation.

Water Depth: To 8 ft; also found in pelagic zone.

REFERENCES

Adams and Hankinson 1928; Amundrud et al. 1974; Cahn 1927; Crossman 1976; Curtis 1949[1]; Eddy and Underhill 1974; Embody 1915; Erickson 1952; Evermann and Clark 1920; Faber 1963, 1967; Forbes and Richardson 1920; Fowler 1923; Greeley 1928, 1929; Hansen 1951; Hubbs and Eschmeyer 1938; Lagler 1948; MacKay 1957b, 1969; Morgan 1951; Nash 1913; ODNR, undated; Olson 1970; Olson and Koopman 1976; Pearse 1918b, 1919; Richardson 1913a; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Surber 1920.

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[1] California

GREENSIDE DARTER

MIGRATION OF ADULTS

Prespawning: Migrate several miles upstream.

Postspawning: Male guards spawning territory; moves downstream to deeper riffle areas after spawning.

SPAWNING

Season: A period of 5-9 weeks period in April-June at 51-66°F[1], observed at 73°F in laboratory.

Site: Swift riffles of moderate-high gradient streams; possibly weedy bays.

Substrate: Eggs are deposited on large rocks or rubble covered with algae, primarily *Cladophora*; also under small pieces of wood.

Water Depth: 1-4 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on algae.

Duration: Eggs hatch in 18 days at 55-58°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found on stream riffles and along shorelines.

Substrate: Algae, rock.

Water Depth: Few inches - 2 ft.

REFERENCES

Baker 1979[1]; Cahn 1927; Fahy 1954; Trautman 1957; Winn 1954, 1957, 1958a,b.

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[1] Tennessee

RAINBOW DARTER

MIGRATION OF ADULTS

Prespawning: Lake residents migrate from deeper water to inshore areas; stream residents migrate upstream beginning in late March.

Postspawning: Male guards nest area for short period before returning to deeper water.

SPAWNING

Season: April-June at water temperatures above 59°F.

Site: Wave-swept lake shorelines and creek mouths or stream riffles.

Substrate: Eggs are deposited at random on gravel, rock, pebbles, sand, or dense vegetation[1].

Water Depth: 4 in.-2 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs are buried in gravel.

Duration: Eggs hatch in 10-12 days at 63-66°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain buried in spawning substrate; young-of-the-year are found along lake shores.

Substrate: Gravel for prolarvae.

Water Depth: No information.

REFERENCES

Balon 1975; Cahn 1927; Cooper 1979; Eddy and Underhill 1974; Hankinson 1919, 1932; Hubbs and Lagler 1958; Reeves 1907; Scott 1967; Seal 1892[1]; Slastenenko 1958; Surber 1920; Toth 1978; Winn 1954, 1957, 1958a,b.

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[1] Laboratory study

IOWA DARTER

MIGRATION OF ADULTS

Prespawning: Move from deeper water to inshore areas.

Postspawning: Return to deeper water after spawning.

SPAWNING

Season: Late March to mid-July, at 54-59°F[1].

Site: Sheltered, sluggish nearshore areas, including creek mouths and stream margins, especially beneath undercut banks.

Substrate: Eggs are deposited on rock, marl, vegetation, mud, organic debris, or compacted root material.

Water Depth: 4 in. - 4 ft[1].

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on bottom, usually in crevices, or on plant roots.

Duration: Eggs hatch in 18-26 days at 55-61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in sheltered areas, including marshes.

Substrate: Vegetation, mud, sand, silt.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Bensley 1915; Cahn 1927; Dymond 1926; Eddy and Underhill 1974; Evermann and Clark 1920; Greeley 1929; Hankinson 1908; Hubbs and Lagler 1958; Jaffa 1917[1], ODNR, undated; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Winn 1954, 1958a,b.

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[1] Colorado

FANTAIL DARTER

MIGRATION OF ADULTS

Prespawning: Migrate from swift riffles in streams to areas of moderate current in late March-April at 44-58°F.

Postspawning: Male guards eggs; female leaves spawning site almost immediately after spawning and returns downstream to larger riffles.

SPAWNING

Season: April-early July at 66-76°F; usually peaks in May.

Site: Areas of moderate current usually just below or above stream riffles or in pools.

Substrate: Eggs are attached to undersides of flat rocks or pieces of wood on bottom of rubble, rock, gravel, or sand.

Water Depth: 12-20 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: Eggs hatch in 14-35 days at 74-63°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are dispersed by current among gravel and vegetation; young-of-the-year are found near spawning riffles or along wave-swept beaches; also may be found in quiet waters[1].

Substrate: Rock, rubble, sand, some vegetation; possibly soft bottom[1].

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Cahn 1927; Cooper 1979; Forbes and Richardson 1920; Greeley 1927, 1929; Hankinson 1932; Hubbs and Lagler 1958; Lake 1936; Langlois 1954; Minckley 1963[1]; Parker et al. 1899; Toth 1978; Trautman 1957; Winn 1954, 1958a.

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[1] Kentucky

JOHNNY DARTER

MIGRATION OF ADULTS

Prespawning: Move from deeper water of lakes or streams, possibly several miles, to shallow inshore areas in early April.

Postspawning: Male guards eggs; returns to deeper areas of lake or stream.

SPAWNING

Season: A 6-week period in April-August, usually in May and June at 63-77°F.

Site: Sheltered nearshore areas, including shorelines, bays, harbors, and creek mouths; areas of moderate current in stream pools.

Substrate: Eggs are attached to undersides of stones, wood, or other objects, on bottom of loose stone, rock, gravel, sand, clay, or silt.

Water Depth: 8 in. - 15 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: Eggs hatch in 5-24 days at 75-61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year (YOY) are found in sheltered areas near spawning grounds, including shorelines, bays, harbors, and lower reaches of rivers; may be near weed beds.

Substrate: Rock, gravel, sand, clay, silt, mud, vegetation.

Water Depth: As shallow as 2 in. for newly hatched larvae; to 82 ft for older YOY.

REFERENCES

Adams and Hankinson 1928; Cahn 1927; Dymond 1926; Eddy and Underhill 1974; Forbes and Richardson 1920; Greeley 1929; Hankinson 1908, 1919, 1932; Hubbs and Lagler 1958; Osburn 1901; Price and Kelly 1976; Raney and Lachner 1942, 1943; Reighard 1913, 1915; Slastenenko 1958; Smith 1963; Speare 1958, 1965; Tilton et al. 1978; Toner 1943; Trautman 1957; Winn 1954, 1958a,b.

YELLOW PERCH

MIGRATION OF ADULTS

Prespawning: Migrate inshore or ascend tributaries, possibly long distances, beginning as early as March at 34°F, just before or after ice breakup; may overwinter in bays prior to spawning.

Postspawning: Return downstream or to offshore areas of lakes.

SPAWNING

Season: A period of 1-4 weeks in April-August, usually April-June, at 37-72°F; spawning peaks at about 43-54°F.

Site: Sheltered littoral areas in lakes and tributaries, including shorelines, harbors, bays, creek mouths, marshes, backwaters, and lagoons; usually near vegetation.

Substrate: Eggs are deposited at random on submerged objects, including vegetation, rocks, brush, and debris, on almost any bottom type.

Water Depth: To 72 ft; usually less than 30 ft.

INCUBATION AND HATCHING

Site: Semibuoyant strands of eggs incubate among vegetation or other submerged objects; current may move eggs away from spawning site.

Duration: Eggs hatch in 5-27 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain near spawning grounds for 3-4 days; larvae then become pelagic in the upper 20 ft of water and are widely distributed by currents; young-of-the-year (YOY) become benthic usually after 4-5 weeks and are found in sheltered nearshore areas; YOY move downstream in tributaries in fall.

Substrate: Vegetation, gravel, rubble, sand, mud, silt.

Water Depth: To 66 ft; highest densities at less than 30 ft.

REFERENCES

Adams and Hankinson 1916, 1928; Amundrud et al. 1974; Bardach 1949; Bean 1912; Buller 1927; Cahn 1927; Calhoun and Coon 1941; Clady 1975, 1976, 1977; Crossman 1976; Eaton 1928; Eddy and Underhill 1974; Embody 1915, 1922; Evermann and Kendall 1920; Faber 1963, 1967; Forbes and Richardson 1920; Forney 1971; FWS 1945; Greeley 1928;

Hankinson 1908; Herman et al. 1959; Houde 1968, 1969a,b; Johnson, C., 1971; Johnson, F., 1969; Lagler 1948; Langlois 1941; Leach 1927; MacKay 1959e, 1969; Maloney and Johnson 1955; McCrimmon 1956; Nash 1913; Noble 1968, 1972, 1975; Patterson 1978; Paxton and Day 1974; Pearse 1918b; Pearse and Achtenberg 1920; Price and Kelly 1976; Raney 1959; Raney and Lachner 1942; Raphael and Jaworski 1979; Reed and Wright 1909; Schneider 1972; Scott 1967; Slastenenko 1958; Smith 1969, 1972; Smith and Moe 1944; Surber 1920; Titcomb 1922; U.S. Comm. Fish Fish. 1900; USDI 1969b; Webster 1975.

LOGPERCH

MIGRATION OF ADULTS

Prespawning: Migrate in large schools from deep water to nearshore areas and into tributaries.

Postspawning: Presumably return to deep water.

SPAWNING

Season: A period of 1-2 weeks in April-August, usually June-July; spawning begins at water temperatures of 50-59°F[1].

Site: Lake shoals and beaches, stream riffles or swift channels, river mouths, and harbors.

Substrate: Eggs are broadcast at random over sand, fine gravel, or rock of 4-6 in. diam., with little or no vegetation.

Water Depth: 4 in. - 15 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs become loosely buried in sand.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are found at the surface inshore[2] near spawning grounds; fry less than 0.6 in. long are dispersed in open water[2] in June; larger fry return to protected nearshore areas[2] and are found near bottom along sheltered beaches, in creek mouths, bays, and harbors; young-of-the-year in streams move downstream to lakes by August.

Substrate: Sand, gravel, rock, rubble; submerged vegetation may or may not be present.

Water Depth: To 132 ft by August.

REFERENCES

Adams and Hankinson 1928; Amundrud et al. 1974; Crossman 1976; Eddy and Underhill 1974; Eigenmann 1896; Faber 1963, 1967; Ellis and Roe 1917; Fish 1929; Greeley and Bishop 1932; Hubbs and Lagler 1958; Hubbs and Strawn 1963[1]; Langlois 1954; Price and Kelly 1976; Reighard 1915, 1920; Scott 1967; Taber 1969[2]; Trautman 1948, 1957; Winn 1954, 1958a,b.

1,2/ Texas

CHANNEL DARTER

MIGRATION OF ADULTS

Prespawning: Move inshore or ascend tributaries.

Postspawning: Return to deeper water immediately after spawning.

SPAWNING

Season: Late June-late July at 69-72°F.

Site: Current-swept lake shoals or stream riffles; spawning territory of each male is centered by a large rock.

Substrate: Eggs are scattered at random over gravel, rock, boulders, or sand.

Water Depth: 18 in. - 5 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs become buried in gravel.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: Sand, mud, silt, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Greeley and Bishop 1932; ODNR, undated; Winn 1954, 1958a,b.

SAUGER

MIGRATION OF ADULTS

Prespawning: Migrate inshore and enter tributaries beginning in March, often before ice breakup; river residents move upstream.

Postspawning: Return to deeper water after spawning.

SPAWNING

Season: A 2-week period[2] in late March-early July, usually April and May, at 39[1] - 54°F.

Site: Lake shorelines, bars, and reefs; bays; riffles in tributaries.

Substrate: Eggs are broadcast on a variety of substrates, including gravel, rock, cobble, boulders, sand, clay, mud, and vegetation.

Water Depth: Less than 2 ft[2] - 30 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs settle to bottom and incubate in cracks and crevices among gravel or boulders[2].

Duration: Eggs hatch in 9 days at about 55°F[3] - 29 days at 40°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain on bottom 7-9 days[2]; larvae hatched in rivers move downstream to lakes[2,4]; larvae smaller than 0.6 in. are planktonic in open water; those larger than 0.6 in. are found inshore in harbors, bays, and river mouths, especially in turbid water; young-of-the-year disperse offshore in July or August[4].

Substrate: Sand, gravel.

Water Depth: Shallow for most of summer; move to depths as great as 198 ft in late summer.

REFERENCES

Carufel 1963[1]; Crossman 1976; Curry and Spacie 1979; Dymond 1926; Eddy and Underhill 1974; Fish 1929; Gammon 1976; Greeley 1929; Langlois 1941; Nelson 1968a[2]; Nelson et al. 1965[3]; ODNR, undated; Priegel 1968, 1969; Scott and Crossman 1973; Slastenenko 1958; Smith and Koenst 1975; Walburg 1972[4].

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[1] North Dakota

[2,4] South Dakota

[3] Laboratory study

WALLEYE

MIGRATION OF ADULTS

Prespawning: Migrate inshore from deep water and enter tributaries, beginning as early as late February, under the ice or just after ice-out; often migrate long distances up tributaries.

Postspawning: Migrate downstream or offshore in May-August and disperse widely; may remain in harbors for 2-3 months before moving into lakes.

SPAWNING

Season: A period of 1-4 weeks in February-June at 34-64°F; usually peaks at 41-53°F.

Site: Exposed, wave-swept lakeshores, reefs, or shoals; bays and river mouths; fast-water areas of tributaries, usually just below waterfalls, rapids, or dams; occasionally in marshes with good current.

Substrate: Eggs are broadcast over clean, firm bottom of rock, rubble, boulders, gravel, sand, or clay, usually free of mud or silt; also over vegetation on firm substrate.

Water Depth: To 30 ft.

INCUBATION AND HATCHING

Site: Eggs may be carried from spawning site by current before settling to bottom; eggs adhere to clean substrate.

Duration: Eggs hatch in 1-4 weeks at 57-40°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain on bottom 3-5 days; postlarvae are carried by current into limnetic zone, especially in bays, where they remain for 2-7 weeks until about 1 in. long; the larger young-of-the-year (YOY) concentrate along shore, then move offshore by October.

Substrate: Clean sand, rock, gravel, hard clay, or mud; usually no vegetation, but YOY may be found near large weed beds.

Water Depth: To 40 ft; YOY larger than 1 in. usually at depths less than 12 ft.

REFERENCES

Adams and Hankinson 1928; Allbaugh and Manz 1964; Anthony and

Jorgensen 1977; Bean 1902, 1903, 1913, 1915; Bennett 1948; Beyerle 1978; Bower 1897; Bradshaw and Muir 1960; Buller 1927; Buss 1960; Cahn 1927; Calhoun and Coon 1941; Cheney 1897; Chevalier 1977; Cobb 1923; Colvin 1975; Cross 1964; Crossman 1976; Dymond 1926; Eddy and Underhill 1974; Evermann and Latimer 1910; Faber 1963, 1967; Forbes and Richardson 1920; Forney 1953, 1963, 1966, 1977; Greeley and Bishop 1932; Hankinson 1908; Hay 1894; Herman 1947; Houde 1967, 1968, 1969a,b; Houde and Forney 1970; Hubbs and Eschmeyer 1938; Hubbs and Lagler 1958; Johnson, C., 1971; Johnson, F., 1961, 1969; Johnson and Hale 1970, 1977; Johnson and Johnson 1971; Johnson et al. 1977; Kmiotek 1952; Lagler 1948; Leach 1927; Maloney and Johnson 1955; McCrimmon 1956; Meehan 1895; Momot et al. 1977; Newburg 1975; Niemuth et al. 1959; Noble 1972; Olson 1972; Olson and Scidmore 1962; Olson et al. 1978; Paxton and Day 1974; Price and Kelly 1976; Priegel 1963, 1966, 1967b, 1968, 1970; Raney 1959; Raney and Lachner 1942; Reighard 1890; Ryder 1977; Schneberger 1938, 1939, 1940; Scidmore 1972, 1974; Scott 1967; Slastenenko 1956, 1958; Smith 1969, 1972; Smith and Koenst 1975; Smith et al. 1952; Smith and Moe 1944; Smith and Pycha 1960; Stoudt 1939; Stoudt and Eddy 1939; Surber 1920; Tucker 1968; U.S. Comm. Fish Fish. 1900; USDI 1969b; Van Oosten and Deason 1957.

BLUE PIKE[1]

MIGRATION OF ADULTS

Prespawning: Migrated inshore and into tributaries.

Postspawning: Returned to deep water by July.

SPAWNING

Season: A 2-week period in late April-early July at 38-48°F.

Site: Lake shoals, bays, and tributaries.

Substrate: Eggs were deposited on gravel, rock, sand or mud.

Water Depth: 15-130 ft.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Smith 1978a.

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[1] This species is believed to be extinct in the Great Lakes.

FRESHWATER DRUM

MIGRATION OF ADULTS

Prespawning: Migrate inshore from deep water and enter bays and tributaries beginning in April at about 43°F.

Postspawning: Return to deep water in lakes during summer.

SPAWNING

Season: April-August at 55-77°F.

Site: Tributaries, harbors, bays, river mouths, lake shores, shoals, or offshore in open water.

Substrate: Eggs are scattered at random in midwater over sand, gravel, rock, rubble, clay, mud or vegetation.

Water Depth: To 42 ft.

INCUBATION AND HATCHING

Site: Buoyant eggs incubate in open water and are widely distributed by currents.

Duration: Eggs hatch in 1-3 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are carried by currents; pelagic postlarvae 0.4-0.8 in. long are abundant offshore; young-of-the-year larger than 0.8 in. become benthic and concentrate in quiet, open water along shorelines, in sloughs, bays, river mouths, and lower reaches of rivers; seem to prefer turbid water.

Substrate: Mud, sand, gravel, vegetation.

Water Depth: To 60 ft.

REFERENCES

Barker 1940; Butler 1962, 1965; Butler and Smith 1950; Eddy and Underhill 1974; Fish 1929; Forbes and Richardson 1920; Garman 1889; Lagler 1948; Langlois 1954; Larmoyeux 1951; McLeod 1953; ODNR, undated; Priegel 1967; Schneider and Hasler 1960; Slastenenko 1958; Smith 1969; Wirth 1958.

MOTTLED SCULPIN

MIGRATION OF ADULTS

Prespawning: Migrate inshore from deep water; may ascend tributaries.

Postspawning: Female returns to deep water immediately after spawning; male guards nest and newly hatched fry; male leaves spawning ground usually by late May.

SPAWNING

Season: Mid-March to late May at 42-62°F.

Site: Current-swept lake shores and shoals, harbors, and riffles in streams.

Substrate: Eggs are deposited under stones or logs on bottom of gravel, rubble, boulders, sand, or firm loam; possibly other substrate if shelter is available; spawning may also occur on rock breakwalls.

Water Depth: 6-14 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate where deposited on undersides of stones or logs, or among gravel or on vegetation.

Duration: Eggs hatch in about 7 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae drop to substrate; larvae may remain near spawning site for several days; young-of-the-year (YOY) are pelagic for short time, then concentrate under rocks along exposed shorelines or in harbors.

Substrate: Rock, rubble, gravel, or vegetation; YOY may move to mud bottom in mid-July.

Water Depth: Larvae to 50 ft; YOY 0.6 in. long at 2-10 in.

REFERENCES

Faber 1963, 1967; Fish 1929; Greeley 1927; Hankinson 1908; Hann 1927; Koster 1936; Ludwig and Norden 1969; Manion 1977; Price and Kelly 1976; Reighard 1915; Ricker 1934; Smith 1922; Speare 1958; Turner 1922; Winn 1958.

SLIMY SCULPIN

MIGRATION OF ADULTS

Prespawning: Move from deep water to intermediate depths or to shorelines.

Postspawning: Gradually return to deeper water during summer.

SPAWNING

Season: Late March-late July, usually May and June, at 41-52°F.

Site: Current-swept lakeshores and tributary rapids; swiftest current is avoided.

Substrate: Eggs are deposited under stones or logs on bottom of rubble, boulders, or gravel; possibly sand or mud if shelter is available; spawning may occur on rock jetties.

Water Depth: More than 1 ft in streams - 270 ft in lakes.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate where deposited on underside of stones or logs.

Duration: Eggs hatch in about 4 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae drop to substrate; larvae may remain near spawning site for several days; young-of-the-year are found inshore, among rocks, and near jetties.

Substrate: Rock, hard clay.

Water Depth: 40-76 ft, mainly at midlevel in the hypolimnion.

REFERENCES

Hubbs and Lagler 1958; Koster 1936; Price and Kelly 1976; Quick 1971; Scott 1967; Scott and Crossman 1973.

SPOONHEAD SCULPIN

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Perhaps late summer or early fall; males collected August 1 at 40°F were running ripe[1], and females collected in August had large eggs.

Site: Perhaps offshore; also in harbors.

Substrate: Eggs may be deposited under stones or logs on rock bottom.

Water Depth: Running-ripe males were collected at 140 ft.

INCUBATION AND HATCHING

Site: Eggs probably incubate where deposited.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Perhaps harbors.

Substrate: No information.

Water Depth: Young-of-the-year 1.1 in. long found at 73 ft in late August.

REFERENCES

Balon 1975; Delisle and Van Vliet 1968[1]; Fish 1929; Scott and Crossman 1973.

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[1] Quebec

FOURHORN SCULPIN

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: November-May, mainly mid-winter; spawning may occur all year; ripe adults are also found in May-August.

Site: Offshore.

Substrate: Eggs are probably deposited underneath objects on bottom of rock or gravel.

Water Depth: Greater than 240 ft; ripe adults collected at 690 ft.

INCUBATION AND HATCHING

Site: Eggs probably incubate where deposited.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Postlarvae may be found along shore just after ice breakup; young-of-the-year (YOY) are found offshore, and also in nearshore waters, including bays and harbors, when low water temperatures prevail.

Substrate: Rock, boulders.

Water Depth: Greater than 20 ft; YOY 0.8 in. long to 714 ft; at lesser depths if water cold enough; larvae usually in hypolimnion.

REFERENCES

Balon 1975; Eddy and Underhill 1974; Fish 1929, 1932; Dymond et al. 1929; Scott 1967; Scott and Crossman 1973.

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15. Supplementary Notes

This document is one of a set of fourteen volumes.

16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area. The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.

The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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b. Identifiers/Open-Ended Terms

Great Lakes, spawning areas, nursery areas, reproduction characteristics

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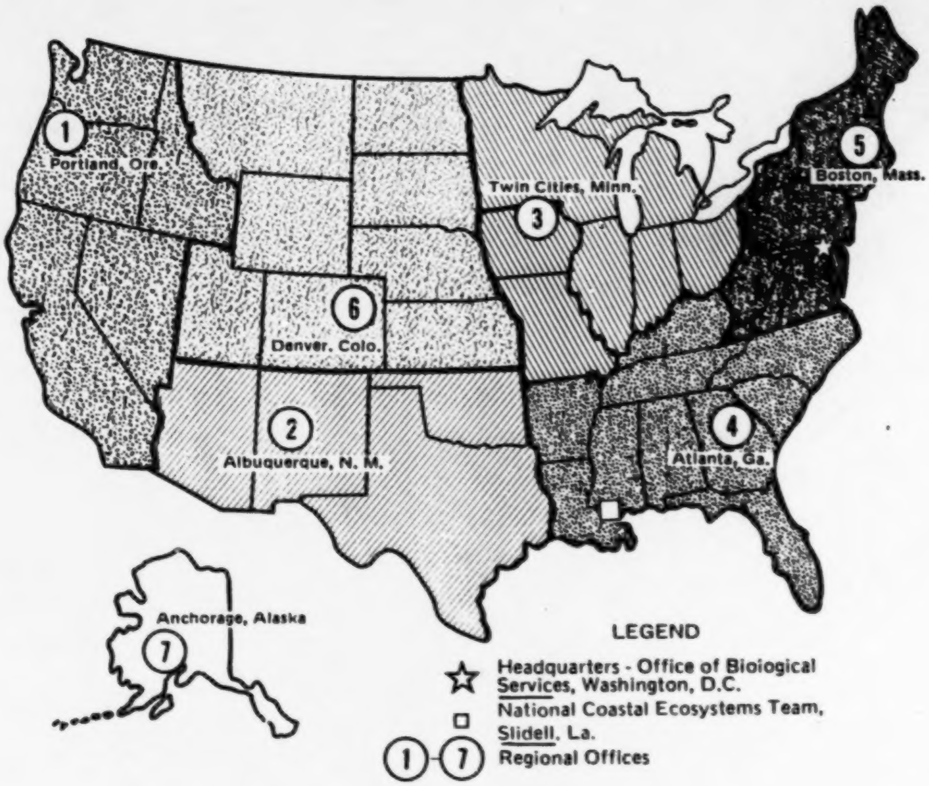
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ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume XIV-Bibliography

Great Lakes-St. Lawrence Seaway Navigation Season Extension Program

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The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

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- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

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Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

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FWS/OBS-82/52
September 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

VOLUME XIV

Literature Cited

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic- juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

I. Spawning and Nursery Areas of Great Lakes Fishes: A Summary by Geographic Area

II. Lake Superior

III. St. Marys River

IV. Lake Michigan

V. Lake Huron

VI. St. Clair River

VII. Lake St. Clair

VIII. Detroit River

IX. Lake Erie

X. Niagara River

XI. Lake Ontario

XII. St. Lawrence River

XIII. Reproductive Characteristics of Great Lakes Fishes

XIV. Literature Cited

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

LITERATURE CITED

Adams, C. C., and T. L. Hankinson. 1916. Notes on Oneida Lake fish and fisheries. Trans. Am. Fish. Soc. 45(3):154-169.

Adams, C. C., and T. L. Hankinson. 1928. The ecology and economics of Oneida Lake fish. Roosevelt Wildl. Ann. 1(3,4):235-548.

Adamson, W. A. 1857. The decrease, restoration, and presentation of salmon in Canada. Can. J. Ind. Sci. Art. 2:1-7.

Addison, W. D., and R. A. Ryder. 1970. An indexed bibliography of North American *Stizostedion* (Pisces, Percidae) species. Ont. Dep. Lands For. Res. Inform. Paper (Fish.) No. 38.

Adelman, I. R. 1979. Unpublished data, Univ. Minn. (Twin Cities).

Agassiz, A. 1878. The development of Lepisosteus. Part I. Proc. Am. Acad. Arts Sci. 13:65-76.

Aitken, W. W. 1936. Some common Iowa fishes. Iowa State Coll. Extension Cir. 224.

Allbaugh, C. A., and J. V. Manz. 1964. Preliminary study of the effects of temperature fluctuations on developing walleye eggs and fry. Prog. Fish Cult. 26(4):175-180.

Alldridge, N. A., and A. M. White. 1980. Spawning site preference for northern pike (*Esox lucius*) in a New York marsh with widely fluctuating water levels. Ohio J. Sci. 80 (April program abstr.): 13.

Allen, A. A. 1914. The red-wing blackbirds: a study in the ecology of a cat-tail marsh. Abstr. Proc. Limnol. Soc. N.Y. 24-25:1-128.

Amundrud, J. R., D. J. Faber, and A. Keast. 1974. Seasonal succession of free-swimming perciform larvae in Lake Opinicon, Ontario. J. Fish. Res. Board Can. 31(10):1661-1665.

Anderson, D. 1966. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-4, Job No. 3, July 1, 1965-June 30, 1966.

Anderson, E. D. 1969. Factors affecting abundance of lake herring, *Coregonus artedii* LeSueur, in western Lake Superior. Ph.D. Thesis, Univ. Minn.

Anderson, E. D., and L. L. Smith, Jr. 1971. Factors affecting abundance of lake herring (*Coregonus artedii* LeSueur) in western Lake Erie. Trans. Am. Fish. Soc. 100:691-707.

Anderson, L. R. 1952. Letter to Fred A. Westerman.

Anderson, P. 1910-1926. Diary and records of catch 1910-1926, Peter Anderson Fish Company.

Anderson, R. F. 1967. Preliminary report on biological observations in northern Lake Michigan utilizing SCUBA. Pages 136-137 in Studies on the environment and eutrophication of Lake Michigan by John C. Ayers and David C. Chandler. Univ. Mich., Great Lakes Res. Div., Spec. Rep. No. 30.

Andrews, L. M., and C. W. Threinen. 1969. Surface water resources of Iron County. Wis. Dep. Nat. Resour., Madison.

Ann Arbor News. 1979a. Steelheaders! Here are Michigan's top steelhead streams. March 29, 1979.

Ann Arbor News. 1979b. Weekend trout opener should be fine. April 26, 1979.

Anthony, D. D., and C. R. Jorgensen. 1977. Factors in the declining contributions of walleye (Stizostedion vitreum vitreum) to the fishery of Lake Nipissing, Ontario 1960-76. J. Fish. Res. Board Can. 34(10):1703-1709.

Applegate, V. C. 1947. The menace of the sea lamprey. Mich. Conserv. 16(4):6, 7, 10.

Applegate, V. C. 1949. The sea lamprey in Michigan. Mich. Conserv. 18(4):13-15.

Applegate, V. C. 1950. Natural history of the sea lamprey, Petromyzon marinus, in Michigan. U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. 55.

Applegate, V. C. 1951a. Sea lamprey investigations. II. Egg development, maturity, egg production, and percentage of unspawned eggs of sea lampreys, Petromyzon marinus, captured in several Lake Huron tributaries. Pap. Mich. Acad. Sci. Arts Lett. 35(1949):71-90.

Applegate, V. C. 1951b. The sea lamprey in the Great Lakes. Sci. Mon. 72(5):275-281.

Applegate, V. C. 1961. Downstream movement of lampreys and fishes in Carp Lake River, Michigan. U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. 387.

Applegate, V. C., and C. L. Brynildson. 1952. Downstream movement of recently transformed sea lampreys, Petromyzon marinus, in the Carp Lake River, Michigan. Trans. Am. Fish. Soc. 81(1951):275-290.

Applegate, V. C., and J. W. Moffett. 1955. The sea lamprey. Sci. Am. 192(4):36-41.

Applegate, V. C., and B. R. Smith. 1950. Sea lamprey spawning runs in the Great Lakes in 1950. U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. 61.

Applegate, V. C., and B. R. Smith. 1951. Movement and dispersion of a blocked spawning run of sea lampreys in the Great Lakes. Trans. North Am. Wildl. Conf. 16:243-251.

Applegate, V. C., B. R. Smith, A. L. McLain, and M. Patterson. 1952. Sea lamprey spawning runs in the Great Lakes--1951. U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. 68.

Applegate, V. C., and H. D. Van Meter. 1970. A brief history of commercial fishing in Lake Erie. U.S. Fish Wildl. Serv. Fish. Leaf. 630.

Applied Biology, Inc. 1979a. Section 316(b) intake monitoring program, Lakeshore Plant, final report.

Applied Biology, Inc. 1979b. Section 316(b) intake monitoring program, Eastlake Plant, final report.

Applied Biology, Inc. 1979c. Section 316(b) intake monitoring program, Avon Lake Plant, final report.

Applied Biology, Inc. 1979d. Section 316(b) intake monitoring program, Ashtabula C Plant, final report.

Applied Biology, Inc. 1979e. Section 316(b) intake monitoring program, Ashtabula A and B Plant, final report.

Aquatic Ecology Associates. 1975. Aquatic ecological studies--Avon Lake, Lakeshore, Eastlake, and Ashtabula Power Plants; interim data report for the period Oct. 1974-Jan. 1975 to Cleveland Electric Illuminating Co.

Aquatic Ecology Associates. 1976a. An aquatic ecological study of the inshore area of Lake Erie in the vicinity of the Ashtabula Steam Electric Generating Stations, Ashtabula, Ohio. Submitted to the Cleveland Electric Illuminating Co.

Aquatic Ecology Associates. 1976b. An aquatic ecological study of the inshore area of Lake Erie in the vicinity of Eastlake Steam Electric Generating Station, Eastlake, Ohio. Submitted to the Cleveland Electric Illuminating Co.

Aquatic Ecology Associates. 1976c. An aquatic ecological study of the inshore area of Lake Erie in the vicinity of the Avon Lake Steam Electric Generating Station, Avon Lake, Ohio. Submitted to Cleveland Electric Illuminating Co.

Aquatic Ecology Associates, Inc. 1977. Aquatic ecology study, Lake Front Plant, Conneaut, Ohio; summary rep. for the period Aug. 16, 1977 to Nov. 15, 1977.

Aquatic Ecology Associates, Inc. 1978a. Aquatic ecology study, Lakefront Plant, Conneaut, Ohio; summary rep. for the period Nov. 16, 1977 to Dec. 31, 1977.

Aquatic Ecology Associates, Inc. 1978b. Aquatic ecology study, Lakefront Plant, Conneaut, Ohio; summary rep. for the period Jan. 1, 1978-April 30, 1978.

Aquatic Ecology Associates, Inc. 1978c. Ecological study, proposed Lake Front Plant site, Conneaut, Ohio; preliminary final draft rep., Vol. 1--Aquatic Rep.

Armstrong, P. B. 1962. Stages in the development of Ictalulrus nebulosus. Syracuse Univ. Press.

Atlantic Fisherman. 1948. Lake Superior trout. Atl. Fisherman 29(3):17, 33.

Auclair, R. P. 1956. The white perch, Morone americana (Gmelin), in Sebasticook Lake, Maine. M.S. Thesis, Univ. Maine.

Avery, E. L. 1974. Reproduction and recruitment of anadromous salmonids in Wisconsin tributaries of Lake Michigan. Wis. Dep. Nat. Resour., Final Rep., Dingell-Johnson Proj. F-83-R, Study No. 108.

Ayers, J. C., and R. F. Anderson. 1969. Hydrological surveys for the Locust Point Power Plant. Part I. General studies. Univ. Mich., Great Lakes Res. Div., Spec. Rep. No. 45.

Ayers, J. C., R. F. Anderson, N. W. O'Hara, D. E. Arnold, and C. C. Kidd. 1970. Hydrological surveys for the Locust Point Power Plant. Part I. General studies. Univ. Mich., Great Lakes Res. Div., Spec. Rep. No. 45.

Ayers, J. C., R. F. Anderson, N. W. O'Hara, D. E. Arnold, and C. C. Kidd. 1970. Hydrological surveys for the Locust Point Power Plant. Part III. Preliminary biological, fisheries, and radiological studies. Univ. Mich., Great Lakes Res. Div., Spec. Rep. No. 45.

Bailey, J. E. 1952. Life history and ecology of the sculpin, Cottus bairdi punctulatus, in southwestern Montana. Copeia 1952(4):243-255.

Bailey, M. M. 1963. Age, growth, and maturity of round whitefish of the Apostle Islands and Isle Royale regions, Lake Superior. U.S. Fish Wildl. Serv. Fish. Bull. 63(1):63-75.

Bailey, M. M. 1964. Age, growth, maturity, and sex composition of the American smelt, Osmerus mordax (Mitchill), of western Lake Superior. Trans. Am. Fish. Soc. 93(4):382-395.

Bailey, M. M. 1969. Age, growth, and maturity of the longnose sucker, Catostomus catostomus, of western Lake Superior. J. Fish. Res. Board Can. 26(5):1289-1299.

Bailey, M. M. 1972. Age, growth, reproduction, and food of the burbot, Lota lota, in southwestern Lake Superior. Trans. Am. Fish. Soc. 101(4):667-674.

Bailey, R. M., and H. M. Harrison, Jr. 1945. The fishes of Clear Lake, Iowa. Iowa State Coll. J. Sci. 20(1):57-77.

Bails, J., R. Hassinger, C. Parker, R. Poff, and A. L. McLain. 1971. The role of dams in an integrated sea lamprey control program in the U.S. waters of the Great Lakes. Great Lakes Fish. Comm. Interim Meet., Append. XX.

Baker, C. T. 1964. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-3, Job No. 2, July 1, 1964-June 30, 1965.

Baker, C. T. 1965. Walleye fry sampling. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-3, Job No. 2, Part 1.

Baker, C. T. 1966a. Walleye spawning area study in western Lake Erie. Ohio Dept. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-4, Job No. 1, July 1, 1965-June 30, 1966.

Baker, C. T. 1966b. Walleye fry sampling. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-3, Job No. 2, Part 2, July 1, 1965-June 30, 1966.

Baker, C. T. 1967a. Walleye fry sampling. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-4, Job No. 2, July 1, 1966-June 30, 1967.

Baker, C. T. 1967b. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-5, Job No. 1, July 1, 1966-June 30, 1967.

Baker, C. T. 1967c. Walleye fry sampling. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-5, Job No. 2, July 1, 1967-June 30, 1968.

Baker, C. T. 1967d. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-6, Job No. 1, July 1, 1967-June 30, 1968.

Baker, C. T. 1969a. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-7, Job No. 1, July 1, 1968-June 30, 1969.

Baker, C. T. 1969b. Walleye fry sampling. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-6, Job No. 2, July 1, 1968-June 30, 1969.

Baker, C. T. 1969c. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-7, Job No. 3, July 1, 1968-June 30, 1969.

Baker, C. T., and H. L. Bower, Jr. 1964. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-2, Job No. 3, Oct. 1963.

Baker, C. T., and H. L. Bower, Jr. 1965. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-3, Job No. 3, July 1, 1964-June 30, 1965.

Baker, C. T., and R. L. Scholl. 1969. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-8, Job No. 1, July 1, 1969-June 30, 1970.

Baker, C. T., and R. L. Scholl. 1970. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-9, Job No. 3, July 1, 1970-June 30, 1971.

Baker, C. T., and R. L. Scholl. 1971a. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-10, Job No. 1, Jan. 1, 1960-June 30, 1970.

Baker, C. T., and R. L. Scholl. 1971b. Coho salmon sampling. Ohio Dep. Nat. Resour. Job Completion Rep., Dingell-Johnson Proj. No. F-35-R-9, Job No. 5, July 1, 1968-June 30, 1971.

Baker, C. T., and R. L. Scholl. 1971c. Walleye sampling. Ohio Dep. Nat. Resour. Job Completion Rep., Dingell-Johnson Proj. No. F-35-R-8 through F-35-R-9, Job No. 2, July 1, 1969-June 30, 1971.

Baker, C. T., and R. L. Scholl. 1972. Survey of offshore fish species in Ohio portion of Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-10, Study No. III, July 1, 1971-June 30, 1972.

Baker, J. M. 1979. Larval development of the greenside darter, _Etheostoma_ _blennioides_ _newmanii_ (Agassiz). Pages 70-91 _in_ Proceedings of the Third Symposium on Larval Fish, R. D. Hoyt, ed., West. Ky. Univ., Bowling Green.

Baldwin, N. S. 1950. The American smelt of South Bay, Manitoulin Island, Lake Huron. Trans. Am. Fish. Soc. 78(1948):176-180.

Baldwin, N. S. 1956. Hybrid trout. Sylva 12(3):6-9.

Balesic, H. 1978. Fish distribution at Lennox GS. Ont. Hydro Res. Div. Rep. No. 78-242-K.

Balesic, H. 1979a. Fish distribution and abundance along the north shore of Lake Ontario--Fall, 1978 intake location study, Interim Report. Ont. Hydro Res. Div. Rep. No. 79-434-K.

Balesic, H. 1979b. Fish distribution and abundance along the north shore of Lake Ontario, summer-early fall, 1978 intake location study, Interim Report. Ont. Hydro Res. Div. Rep. No. 79-363-K.

Balesic, H. 1979c. Literature review of physical characteristics and fishes of the nearshore zone of Lake Ontario. Ont. Hydro Res. Div. Rep. No. 79-165-K.

Ball, F. L., and R. L. Scholl. 1973. Walleye and related species year class survival in western Lake Erie. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. F-35-R-11, Study II, July 1, 1972-June 30, 1973.

Ball, J. R. 1971. Oak Creek and Point Beach thermal pollution studies. Wis. Dep. Nat. Resour. Presented in Append. C of Wis. Elec. Power Co. and Wis. Mich. Power Co. 1971a and 1971b.

Balon, E. K. 1975. Reproductive guilds of fishes: a proposal and definition. J. Fish. Res. Board Can. 32(6):821-864.

Bams, R. A. 1959. Review of the sea lamprey problem. Append. D, pages 14-15 in Proc. 12th meeting, Canadian Committee on Freshwater Fisheries Research.

Bardach, J. E. 1949. The contributions to the ecology of the yellow perch (Perca flavescens Mitchell) in Lake Mendota, Wisconsin. Ph.D. Thesis, Univ. Wis.

Barker, H. W. 1940. Sheepshead-drum fish. Wis. Conserv. Bull. 5(3):58-59.

Barnes, M. D. 1979. Inventory and review of literature data sources pertaining to ichthyological and fisheries research in the nearshore zone of Lake Erie. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 127.

Barnes, M. D., and J. M. Reutter. 1979. Fish population studies from Lake Erie near the Davis-Besse Nuclear Power Station during 1978. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 105.

Barnett, C. F. 1969. Walleye fry sampling. Ohio Dep. Nat. Resour. Job Completion Rep., Dingell-Johnson Proj. No. F-35-R-1 through F-35-R-7, Job No. 2, July 1, 1962-June 30, 1969.

Barney, R. L., and B. J. Anson. 1923. Life history and ecology of the orange spotted sunfish, Lepomis humilis. U.S. Comm. Fish. Doc. No. 938.

Barnston, G. 1874. II. Miscellaneous notes and correspondence relative to the whitefish. Pages 79-89 in Append. A. The Fisheries of the Great Lakes and the (species of Coregonus or whitefish) of Part II. Rep. of the Commissioners for 1872 and 1873. U.S. Comm. Fish Fish.

Basch, R. E. 1968. Age, growth, and food habits of the spottail shiner, Notropis hudsonius (Clinton), in Little Bay de Noc, Lake Michigan. M.S. Thesis, Mich. State Univ.

Battle, H. I. 1940. The embryology and larval development of the goldfish (Carassius auratus L.) from Lake Erie. Ohio J. Sci. 40(2):82-93.

Baz, M. 1979. Pere Marquette steelheads. Mich. Out-of-Doors 33(4):80-83.

Beak Consultants Inc. 1976. Fisheries survey of Saginaw Bay related to the thermal effects of the Karn-Weadock Generating Stations (Draft). Prep. for Consumers Power Co.

Bean, T. H. 1884a. The burbot--Lota maculosa. Pages 235-240 in The Fisheries and Fishery Industries of the United States, Sect. I, Part III., G. B. Goode, ed. U.S. Comm. Fish Fish., Wash., D.C.

Bean, T. H. 1884b. On the occurrence of the branch alewife in certain lakes of New York. Pages 588-593 in The Fisheries and Fishery Industries of the United States, Sect. I, Part III., G. B. Goode, ed. U.S. Comm. Fish Fish., Wash., D.C.

Bean, T. H. 1902. Food and game fishes of New York. 7th Rep., N.Y. For., Fish, Game Comm.

Bean, T. H. 1903. Catalogue of the fishes of New York. N.Y. State Museum Bull. 60, Zoology 9:1-784.

Bean, T. H. 1908. The muskalonge of the Ohio basin. Trans. Am. Fish. Soc. 37:145-151.

Bean, T. H. 1912. 1st Annual Report of the Fish Culturist (1911). Annu. Rep. N.Y. Conserv. Comm. 1:3-57.

Bean, T. H. 1913. 2nd Annual Report of the Fish Culturist (1912). Annu. Rep. N.Y. Conserv. Comm. 2:3-57.

Bean, T. H. 1915. 4th Annual Report of the Fish Culturist (1914). N.Y. Conserv. Comm. 4:1-32.

Beard, T. D. 1971. Population dynamics of young bluegills. Wis. Dep. of Nat. Resour., Dingell-Johnson Proj. No. F-83-R-7, Study 204, Jan. 1, 1971-Dec. 31, 1971.

Beard, T. D. 1972. Survival of bluegill eggs on the nest. Wis. Dep. of Nat. Resour., Dingell-Johnson Proj. No. F-83-R-7, Study 204, July 1, 1971-June 30, 1972.

Becker, G. C. 1962. Intra-specific variation in Rhinichthys C. cataractae (Valenciennes) and Rhinichthys atratulus meleagris (Agassiz) and anatomical and ecological studies of Rhinichthys C. cataractae. Ph.D. Thesis, Univ. Wis.-Madison.

Becker, G. C. 1976. Inland fishes of the Lake Michigan drainage basin. Environmental status of the Lake Michigan region. Vol. 17. ANL/ES-40, Argonne Natl. Lab.

Beeman, H. W. 1924. Habits and propagation of the small-mouthed black bass. Trans. Am. Fish. Soc. 54:92-107.

Beeton, A. M. 1966. Indices of Great Lakes eutrophication. Proc. Conf. Great Lakes Res. 9:1-8.

Beeton, A. M. 1969. Changes in the environment and biota of the Great Lakes. Pages 150-187 in Eutrophication: causes, consequences, correctives; Proceedings of a symposium. Natl. Acad. Sci., Wash., D.C.

Behmer, D. J., and G. R. Gleason. 1975. Winter fish movement at a proposed bubbler site, St. Marys River system. Lake Superior State Coll., for U.S. Fish Wildl. Serv.

Belding, D. L. 1934. The spawning habits of the Atlantic salmon. Trans. Am. Fish. Soc. 64:211-218.

Belding, D. L., and J. A. Kitson. 1934. Spring-run and fall-run Atlantic salmon. Trans. Am. Fish. Soc. 64:225-230.

Bell, R. 1895. Honeycombed limestones in Lake Huron. Bull. Geol. Soc. Am. 6:297-304.

Belonger, B. 1979. Trawl sampling--yellow perch assessment. Correspondence/memorandum to Russell Daly, Wis. Dep. Nat. Resour., Marinette.

Belonger et al. 1979. Yellow perch assessment in southern Green Bay 1978. Correspondence/memorandum to Russell Daly, Wis. Dep. Nat. Resour., Marinette.

Bennett, G. W. 1954. Largemouth bass in Ridge Lake, Coles County, Illinois. Bull. Ill. Nat. Hist. Surv. 26(Artic. 2):217-276.

Bennett, G. W., and W. F. Childers. 1966. The lake chubsucker as a forage species. Prog. Fish Cult. 28(2):89-92.

Bennett, L. H. 1948. Pike culture at the New London, Minnesota, station. Prog. Fish Cult. 10(2):95-98.

Bensley, B. A. 1915. I. The fishes of Georgian Bay. Contrib. to Canadian Biology. Sessional Paper No. 39b, Suppl. to 47th Annu. Rep. Dep. Marine Fish., Fish. Branch.

Benson, N. G. 1953. The importance of groundwater to trout populations. Trans. 18th N. Am. Wildl. Conf.:269-281.

Berg, R. E. 1976. The fish community of the lower Dead River, Michigan, a tributary of Lake Superior. M.A. Thesis, North. Mich. Univ.

Berg, R. E., P. A. Doepke, and P. R. Hannuksela. 1975. First occurrence of the brook silverside, *Labidesthes sicculus*, in a tributary of Lake Superior. J. Fish. Res. Board Can. 32(12):2541-2542.

Bergstedt, R. 1978. Cruise report, Project 905, Lake Ontario. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab.

Berst, A. H. undated. Rondeau Bay fishery study, 1950. Ont. Min. Nat. Resour.

Berst, A. H. 1953a. Preliminary report on spawning of smallmouth bass in Long Point Bay, Lake Erie, 1953. Ont. Dep. Lands For.

Berst, A. H. 1953b. Spawning of smallmouth bass in Long Point Bay, Lake Erie, 1953. Ont. Dep. Lands For.

Berst, A. H. 1954. Lake Erie smelt fishing experiment. Ont. Dep. Lands For., Fish Wildl. Manage. Rep. 17:1-6.

Berst, A. H., and A. M. McCombie. 1975. Rainbow trout and splake in a southern Ontario reservoir. Ont. Min. Nat. Resour. Res. Rep. No. 96.

Berst, A. H., and N. R. Payne. 1974. Stream migration of yearling splake (*Salvelinus fontinalis* X *S. namaycush*) planted in Georgian Bay. J. Fish. Res. Board Can. 31(2):226-229.

Berst, A. H., and G. R. Spangler. 1970a. A historical review of the salmonid and coregonid fisheries of Lake Huron. Ont. Dep. Lands For., Res. Branch, Maple, Ont.

Berst, A. H., and G. R. Spangler. 1970b. Population dynamics of F_1 splake (*Salvelinus fontinalis* X *S. namaycush*) in Lake Huron. J. Fish. Res. Board Can. 27(6):1017-1032.

Berst, A. H., and G. R. Spangler. 1973. Lake Huron: the ecology of the fish community and man's effects on it. Great Lakes Fish. Comm. Tech. Rep. No. 21.

Berst, A. H., and A. A. Wainio. 1967. Lamprey parasitism of rainbow trout in Georgian Bay. J. Fish. Res. Board Can. 24(12):2539-2548.

Bertrand, G., J. Lang, and J. Ross. 1976. The Green Bay watershed, past/present/future. Inst. for Environ. Studies, Univ. Wis.-Madison. Univ. Wis. Sea Grant Coll. Prog. Tech. Rep. No. 229.

Beyerle, G. B. 1978. Survival and growth of walleye fingerlings of different sizes in ponds with bluegills. Mich. Dep. Nat. Resour., Annu. Rep., Pages 127-129 in Dingell-Johnson Proj. F-35-R-4, October 1, 1977 to September 30, 1978.

Bidgood, B. F., and A. H. Berst. 1969. Lethal temperatures for Great Lakes rainbow trout. J. Fish. Res. Board Can. 26(2):456-459.

Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv. Fish. Bull. 53(74).

Bio Systems Research, Inc. 1978a. 1977 fish egg and larvae program, lake/screenhouse surveys, Ginna Nuclear Power Station. RGE Rep. No. B-13-058.

Bio Systems Research, Inc. 1978b. 1977 fish egg and larvae program, lake/screenhouse surveys, Russell Power Station. RGE Rep. No. B-7-059.

Bissell, J. H. 1890. The Detroit whitefish station. Trans. Am. Fish. Soc. 19:16-20.

Bjorn, E. E. 1939. Preliminary observations and experimental study of the ling, Lota maculosa (LeSueur), in Wyoming. Trans. Am. Fish. Soc. 69:192-196.

Black, J. D. 1945. Natural history of the northern mimic shiner, Notropis volucellus volucellus. Invest. Ind. Lakes Streams 2(18):449-469.

Blair, A. A. Salmon (Salmo salar) of the Miramichi River system, 1931. M.S. Thesis, Univ. Toronto.

Blair, A. A. 1938. Scales of Lake Ontario salmon indicate a land-locked form. Copeia 1938(4):206.

Blue Pike Recovery Team. 1975. Blue pike recovery plan. Submitted to U.S. Fish Wildl. Serv. by A. J. Trandahl, Team Leader.

Bodola, A. 1955. The life history of the gizzard shad, Dorosoma cepedianum (LeSueur), in western Lake Erie. Ph.D. Thesis, Ohio State Univ.

Bodola, A. 1966. The life history of the gizzard shad, Dorosoma cepedianum (LeSueur), in western Lake Erie. U.S. Fish Wildl. Serv. Fish. Bull. 65(2):391-425.

Bohr, J. R. 1980. Abundance, distribution and community interactions of demersal fishes inhabiting a new pumped storage reservoir on Lake Michigan near Ludington, Michigan. M.S. Thesis, Mich. State Univ. Presented as 1978 Annu. Rep., Ludington Proj., Vol. 1, No. 2, submitted to Consumers Power Co.

Bostock, A. R. 1967. The ecology of the trout-perch, Percopsis omiscomaycus, in Lake Superior. M.S. Thesis, Univ. Mich.

Bower, S. 1897. Detroit Station and River fisheries. Pages 24-36 in 12th Bienn. Rep. Mich. State Board Fish Comm., Dec. 1, 1894-Dec. 1, 1896, Lansing, Mich.

Bower, S. 1898. Natural versus assisted reproduction of certain kinds of fishes. Trans. Am. Fish. Soc. 27:46-56.

Bower, S. 1910. The rainbow trout in Michigan. Trans. Am. Fish. Soc. 39(1909):130-142.

Bower, S. 1954. First fish of spring. Mich. Conserv. 23(2):3-4.

Bowman, E. W. 1974. Lake Erie bottom trawl explorations, 1962-66. U.S. Natl. Mar. Fish. Serv. Spec. Sci. Rep.-Fish 674.

Bowman, M. L. 1970. Life history of the black redhorse, *Moxostoma duquesnei* (LeSueur), in Missouri. Trans. Am. Fish. Soc. 99(3):546-559.

Bradshaw, J., and B. S. Muir. 1960. The 1960 spawning run of yellow pickerel at Bobcaygeon in relation to water temperature. Ont. Dep. Lands For. Spec. Fish Wildl. Bull. 3:4-6.

Braekevelt, C. R., and D. B. McMillan. 1967. Cyclic changes in the ovary of the brook stickleback, *Eucalia inconstans* (Kirtland). J. Morph. 123:373-396.

Braem, R. A., and P. C. Rugen. 1976. Interim report on sea lamprey control to Great Lakes Fishery Commission (June-November 1976). Presented at Great Lakes Fish. Comm., Interim Meet., Ann Arbor, Mich., Dec. 14-15, 1976.

Braem, R. A., and P. C. Rugen. 1977a. Sea lamprey control in Lake Erie in 1976. Page 27, Append. V, in Minutes (with append.) of Lake Erie Comm., 1977 Annu. Meet., Great Lakes Fish. Comm.

Braem, R. A., and P. C. Rugen. 1977b. Sea lamprey control in Lake Ontario in 1976. Append. VI in Lower Great Lakes Comm., 1977 Annu. Meet., Great Lakes Fish. Comm.

Brandt, Stephen B. 1978. Thermal ecology and abundance of alewife (*Alosa pseudoharengus*) in Lake Michigan. Ph.D. Thesis, Univ. Wis.

Brasch, J. 1950. The lampreys of Wisconsin. Wis. Conserv. Bull. 15(9):13-16.

Brasch, J. G. 1958. Draw-Downs: Fish management tool. Wis. Conserv. Bull. 23(12):25-28.

Brasch, J., J. McFadden, and S. Kmiotek. 1962. The eastern brook trout, its life history, ecology and management. Wis. Conserv. Dep. Publ. No. 226.

Brass, J. L. 1938. Need millions of bluegills to meet heavy demand. Mich. Conserv. 7(11):4.

Brazo, D. C. 1973. Fecundity, food habits and certain allometric features of the yellow perch, *Perca flavescens* (Mitchill), before operation of a pumped storage project on Lake Michigan. M.S. Thesis, Mich. State Univ.

Brazo, D. C., and C. R. Liston. 1977. A study of the fishes associated with the offshore rock jetties of the Ludington Pumped Storage Power Plant on Lake Michigan during 1976. 1976 Annu. Rep., Ludington Fish. Res., Vol. I, No. 2.

Brazo, D. C., C. R. Liston, and R. C. Anderson. 1978. Life history of the longnose dace, *Rhinichthys cataractae*, in the surge zone of eastern Lake Michigan near Ludington, Michigan. Trans. Am. Fish. Soc. 107(4):550-556.

Brazo, D. C., P. I. Tack, and C. R. Liston. 1975. Age, growth, and fecundity of yellow perch, *Perca flavescens*, in Lake Michigan near Ludington, Michigan. Trans. Am. Fish. Soc. 104(4):726-730.

Breder, C. M., Jr. 1935. The reproductive habits of the common catfish *Amelurus nebulosus* (LeSueur), with a discussion of their significance in ontogeny and phylogeny. Zoologica 19(3):143-185.

Breder, C. M., Jr. 1936. The reproductive habits of the North American sunfishes (family Centrarchidae). Zoologica 21(1):1-48.

Breder, C. M., Jr. 1962. On the significance of transparency in Osteichthid fish eggs and larvae. Copeia 1962(3):561-567.

Breder, C. M., Jr., and D. E. Rosen. 1966. Modes of reproduction in fishes. The Natural History Press, Garden City, N.Y.

Brooke, L. T., and P. J. Colby. 1980. Development and survival of embryos of lake herring at different constant oxygen concentrations and temperatures. Prog. Fish Cult. 42(1):3-9.

Brooks, A. S., and G. L. Seegert. 1977. The effects of intermittent chlorination on the biota of Lake Michigan. Univ. Wis., Cent. Great Lakes Stud. Spec. Rep. No. 31.

Brown, C. J. D., and J. W. Moffett. 1942. Observations on the number of eggs and feeding habits of the cisco (*Leucicthys artedi*) in Swains Lake, Jackson County, Michigan. Copeia 1942(3):149-152.

Brown, E. H., Jr. 1968. Population characteristics and physical conditions of alewives, *Alosa pseudoharengus*, in a massive dieoff in Lake Michigan, 1967. Great Lakes Fish. Comm. Tech. Rep. No. 13.

Brown, E. H., Jr. 1970a. Extreme female predominance in the bloater (*Coregonus hoyi*) of Lake Michigan in the 1960's. Pages 501-514 *in* Biology of Coregonid Fishes, C. C. Lindsey and C. S. Woods, eds., Univ. Manitoba Press, Winnipeg.

Brown, E. H., Jr. 1970b. Preliminary summary of assessment trawling for alewives and bloaters in Lake Michigan. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., Admin. Rep.

Brown, E. H., Jr. 1972. Population biology of alewives, *Alosa pseudoharengus*, in Lake Michigan, 1949-70. J. Fish. Res. Board Can. 29(5):477-500.

Brown, E. H., Jr. 1977. Report of the Lake Michigan lake trout technical committee. Pages 31-39, Append. IV, *in* Minutes (with append.) of Lake Michigan Comm., 1977 Annu. Meeting, Great Lakes Fish. Comm.

Brown, E. H., and C. F. Clark. 1965. Length-weight relationships of northern pike, *Esox lucius*, from East Harbor, Ohio. Trans. Am. Fish. Soc. 94(4):404-405.

Brown, E. H., Jr., and C. R. Norden. 1970. Fin degeneration of young-of-the-year *Alosa pseudoharengus* (Clupeidae) in southern Lake Michigan. Copeia 1970(4):766-769.

Brown, E. H., Jr., and L. Wells. 1975. Status of major species in Lake Michigan. Pages 97-103, Append. VI(A), *in* Minutes (with append.) of Lake Michigan Comm., 1975 Annu. Meet., Great Lakes Fish. Comm.

Brown, E. H., Jr., and L. Wells. 1976. Status of major fish species in Lake Michigan. Pages 54-61, Append. VII(B), *in* Minutes (with append.) of Lake Michigan Comm. Meet., Great Lakes Fish. Comm.

Bryant, W. 1975. Status of major fish stocks in Michigan waters of Lake Erie and Lake St. Clair-1974. Pages 38-53 *in* Lake Erie Comm. Annu. Rep., Great Lakes Fish. Comm., March 11-12, 1975.

Bryant, W. 1977. Status of major fish species in Lake St. Clair and Michigan waters of Lake Erie-1976. Pages 89-95, Append. IX, *in* Minutes (with append.) of Lake Erie Comm., 1977 Annu. Meet., Great Lakes Fish. Comm.

Brynildson, C. L. 1957. The smallmouth bass in southern Wisconsin streams. Wis. Conserv. Bull. 22(8):20-22.

Brynildson, O. M., V. A. Hacker, and T. A. Klick. 1963. Brown trout, its life history, ecology and management. Wis. Conserv. Dep. Publ. No. 234.

Bucholz, M. 1957. Age and growth of river carpsucker in Des Moines River, Iowa. Proc. Iowa Acad. Sci. 64:589-600.

Budd, J. C. 1954. Lake Superior trout investigation. Append. No. 11a *in* Annu. Rep. to the Great Lakes Res. Comm., 1954, Sect. 2.

Budd, J. C. 1955. Lake Superior trout investigation. Append. No. 11a *in* Annu. Rep. to the Great Lakes Res. Comm., 1954.

Budd, J. 1957. Movements of tagged whitefish in northern Lake Huron and Georgian Bay. Trans. Am. Fish. Soc. 86(1956):128-134.

Buettner, H. J. 1961. Recoveries of tagged, hatchery-reared lake trout from Lake Superior. Trans. Am. Fish. Soc. 90(4):404-412.

Buffalo Waterfront Development Committee. undated. 208 Water Quality Study--Important Fish. Resour.

Buller, C. R. 1927. A treatise on the fish of Pennsylvania. Pa. Board Fish. Comm. Bull. No. 4.

Burner, C. J. 1951. Characteristics of spawning nests of Columbia River salmon. U.S. Fish Wildl. Serv. Fish. Bull. 61:97-110.

Burns, R. 1979. State spawn control? The Ann Arbor News, November 29.

Burr, B. M., and M. A. Morris. 1977. Spawning behavior of the shorthead redhorse, Moxostoma macrolepidotum, in Big Rock Creek, Illinois. Trans. Am. Fish. Soc. 106(1):80-82.

Busch, W-D., R. Scholl, and W. L. Hartman. 1975. Environmental factors affecting the strength of walleye (Stizostedion vitreum vitreum) year classes in western Lake Erie, 1960-70. J. Fish. Res. Board Can. 32(10):1733-1743.

Buss, D., and E. D. Warner. 1972. Seasonal ultrastructural variations in the rostral neuropophysis of the alewife in Lake Michigan. Proc. Conf. Great Lakes Res. 15:35-44.

Buss, K. 1960. The muskellunge. Pa. Fish. Comm., Benner Spring Fish Res. Stn., Special Purpose Rep.

Buss, K. 1961. The northern pike. Pa. Fish. Comm., Benner Spring Fish. Res. Stn., Special Purpose Rep.

Buss, K., and A. Larsen. 1961. The northern pike in Presque Isle Bay, Lake Erie. Pa. Angler 30(9):4-6.

Buss, K., J. Meade III, and D. R. Graff. 1978. Reviewing the esocid hybrids. Pages 210-216 in Selected Coolwater Fishes of North America, R. L. Kendall, ed., Am. Fish. Soc. Spec. Publ. No. 11.

Buss, K., and J. Miller. 1967. Interspecific hybridization of esocids, hatching success, pattern development, and fertility of some F_1 hybrids. U.S. Bur. Sport Fish. Wildl. Tech. Pap. No. 14.

Butler, R. L. 1962. The status of the freshwater drum, Aplodinotus grunniens Rafinesque, in the commercial fishery of the Upper Mississippi River. Ph.D. Thesis, Univ. Minn.

Butler, R. L. 1965. Freshwater drum, Aplodinotus grunniens, in the navigational impoundments of the Upper Mississippi River. Trans. Am. Fish. Soc. 94(4):339-349.

Butler, R. L., and L. L. Smith, Jr. 1950. The age and rate of growth of the sheepshead, Aplodinotus grunniens Rafinesque, in the Upper Mississippi River navigation pools. Trans Am. Fish. Soc. 79(1949):43-54.

Buynak, G. L., and H. W. Mohr. 1978. Larval development of the northern hog sucker (Hypentelium nigricans), from the Susquehanna River. Trans. Am. Fish. Soc. 107(4):595-599.

Buynak, G. L., and H. W. Mohr. 1979a. Larval development of the shorthead redhorse (Moxostoma macrolepidotum) from the Susquehanna River. Trans. Am. Fish. Soc. 108(2):161-165.

Buynak, G. L., and H. W. Mohr. 1979b. Larval development of creek chub and fallfish from two Susquehanna River tributaries. Prog. Fish-Cult. 41(3):124-129.

Cady, E. R. 1945. Fish distribution, Norris Reservoir, Tennessee, 1943. I. Depth distribution of fish in Norris Reservoir. Rep. Reelfoot Lake Biol. Stn. 9:103-114.

Cahill, W. 1977. Notes of an interview conducted by J. Elrod and R. O'Gorman. Oct. 13, 1977.

Cahn, A. R. 1927. An ecological study of southern Wisconsin fishes: the brook silversides (Labidesthes sicculus) and the cisco (Leucichthys artedi) in their relations to the region. Ill. Biol. Monogr. 11(1):1-151.

Cahn, A. R. 1936. Observations on the breeding of the lawyer, Lota maculosa. Copeia 1936(3):163-165.

Calhoun, W. T., and C. L. Coon. 1941. Wisconsin game fish. Wis. Conserv. Comm. Publ. 201.

Campbell, J. S., and H. R. MacCrimmon. 1970. Biology of the emerald shiner Notropis atherinoides (Rafinesque) in Lake Simcoe, Canada. J. Fish. Biol. 2:259-273.

Canada Department of Marine and Fisheries. 1905. 37th Annu. Rep. (1904).

Canadian Fisherman. 1924a. Ontario hatchery production. 11(5):108.

Canadian Fisherman. 1924b. Spring salmon in Lake Ontario. 11(5):123.

Canfield, H. L. 1922. Care and feeding of buffalo fish in ponds. U.S. Bur. Fish. Econ. Circ. No. 56.

Canfield, H. L. 1947. Artificial propagation of those channel cats. Prog. Fish Cult. 9(1):27-30.

Carbine, W. F. 1938. The pike is both a prized and spurned fish. Mich. Conserv. 7(12):6-8.

Carbine, W. F. 1939. Observations on the spawning habits of centrarchid fishes in Deep Lake, Oakland County, Michigan. Pages 275-287 in Trans. North Am. Wildl. Conf.

Carbine, W. F. 1941. Observations on the life history of the northern pike, *Esox lucius* L., in Houghton Lake, Michigan. Trans. Am. Fish. Soc. 71:149-164.

Carbine, W. F. 1943. The artificial propagation and growth of the common white sucker, *Catostomus c. commersonii*, and its value as a bait and forage fish. Copeia 1943(1):48-49.

Carbine, W. F. 1944. Egg production of the northern pike, *Esox lucius* L., and the percentage survival of eggs and young on the spawning grounds. Pap. Mich. Acad. Sci. 29(1943):123-137.

Carbine, W. F., and D. S. Shetter. 1945. Examples of use of two-way fish weirs in Michigan. Trans. Am. Fish. Soc. 73(1943):70-89.

Carl, L. M. 1977. Natural reproduction by chinook salmon. Mich. Dep. Nat. Resour., Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-3, July 1, 1976-Sept. 30, 1977.

Carl, L. M. 1978. Natural production of chinook salmon. Mich. Dep. Nat. Resour. Study Perf. Rep., Proj. F-35-R-4. Pages 225-242 *in* Dingell-Johnson Annu. Rep., Oct. 1, 1977-Sept. 30, 1978.

Carl, L. M. 1979. Natural reproduction of chinook salmon. Mich. Dep. Nat. Resour. Study Perf. Rep., Proj. F-35-R-5. Pages 143-146 *in* Dingell-Johnson Annu. Rep., Oct. 1, 1978-Sept. 30, 1979.

Carline, R. F. 1980. Features of successful spawning site development for brook trout in Wisconsin ponds. Trans. Am. Fish. Soc. 109(4):453-457.

Carlson, H., L. M. Andrews, and C. W. Threinen. 1977. Surface water resources of Oconto County. Wis. Dep. Nat. Resour., Madison.

Carnes, W. C., Jr. 1958. Contributions to the biology of the eastern creek chubsucker, *Erimyzon oblongus* (Mitchell). M.S. Thesis, N.C. State Coll.

Caroots, M. S. 1976. A study of the gizzard shad *Dorosoma cepedianum* (LeSueur) from Lake Erie near Cleveland, Ohio. M.S. Thesis, John Carroll Univ.

Carr, I. A. 1962. Distribution and seasonal movements of Saginaw Bay fishes. U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. 417.

Carter, H. H., J. R. Schubel, R. E. Wilson, and P. M. J. Woodhead. 1977. A rationale for evaluating thermally induced biological effects due to once-through cooling systems. State Univ. N.Y.-Stony Brook, Mar. Sci. Res., Spec. Rep. 7, Ref. 77-3.

Carufel, L. H. 1963. Life history of saugers in Garrison Reservoir. J. Wildl. Manage. 27(3):450-456.

Casselman, J. M. 1967. Age and growth of the northern pike Esox lucius (Linneaus) of the Upper St. Lawrence River. M.S. Thesis, Univ. Guelph.

CDM/Limnetics. 1976a. Final report, cooling water intake structure study for Manitowoc Public Utilities, Manitowoc, Wis.

CDM/Limnetics. 1976b. Final report--cooling water intake structure study--Winslow Plant for Superior Water, Light and Power Company, Superior, Wisconsin.

CDM/Limnetics. 1976c. Review of the literature on Lake Michigan fish.

CDM/Limnetics. 1977. The lake-wide effects of impingement and entrainment on the Lake Michigan fish populations for Commonwealth Edison Company, Northern Indiana Public Service Company, Indiana and Michigan Power Company and Consumers Power Company.

Center for Lake Erie Area Research. 1975a. Pre-operational aquatic ecology monitoring program for the Davis-Besse Nuclear Power Station, Unit 1. Prog. Rep. July 1-Dec. 31, 1974, Prep. for Toledo Edison Co.

Center for Lake Erie Area Research. 1975b. Pre-operational aquatic ecology monitoring program for the Davis-Besse Nuclear Power Station, Unit 1. Prog. Rep. Jan. 1-June 30, 1975, Prep. for Toledo Edison Co.

Center for Lake Erie Area Research. 1976. Pre-operational aquatic ecology monitoring program for the Davis-Besse Nuclear Power Station, Unit 1. Prog. Rep. July 1-Dec. 31, 1975, Prep. for Toledo Edison Co.

Center for Lake Erie Area Research and Franz Theodore Stone Laboratory. 1977. Annu. Rep. of the Lake Erie program 1976-1977. Coll. of Biol. Sci., Ohio State Univ.

Chamberlain, A. J. 1976a. Short-term effects of 2-year dock construction activity on fishes in the Nanticoke region of Long Point Bay, Lake Erie. Draft Rep. No. 2, Construction Phase 2. Nanticoke Fish Study, Ont. Min. Nat. Resour.

Chamberlain, A. J. 1976b. The acute and sub-acute effects of underwater rock blasting and dredging on the fishes in Long Point Bay, Lake Erie. Rep. No. 1, Construction Phase 1, Mar.-Nov. 1975, Nanticoke Project, Ont. Min. Nat. Resour.

Chapman, C. R. 1954a. A guide to fishing Sandusky Bay. Ohio Conserv. Bull. 18(6):16-17,30.

Chapman, C. R. 1954b. Our Sandusky Bay fishery. Ohio. Conserv. Bull. 18(7):16-17,28.

Chapman, C. R. 1955. Sandusky Bay Report. Ohio Div. Wildl., Columbus.

Chen, M. Y. 1970. Reproduction of American smelt, Osmerus mordax (Mitchill). Ph.D. Thesis, Univ. Waterloo.

Cheney, A. N. 1897. The pike-perch (Stizostedion vitreum). 2nd Annu. Rep. N.Y. Comm. Fish. Game For. (1896):203-206.

Chevalier, J. R. 1977. Changes in walleye (Stizostedion vitreum vitreum) population in Rainy Lake and factors in abundance, 1924-75. J. Fish. Res. Board Can. 34(10):1692-1702.

Childers, W. F. 1967. Hybridization of four species of sunfishes (Centrarchidae). Ill. Nat. Hist. Surv. Bull. 29(3):159-214.

Chiotti, T. L. 1973. Food habits, reproductive biology, and lamprey scarring of planted lake trout (Salvelinus namaycush) in the inshore waters of Lake Michigan at Ludington, Michigan. M.S. Thesis, Mich. State Univ.

Christie, W. J. 1954. Report on Lake Ontario investigations, 1954. Append. No. 20 in Annu. rep. to the Great Lakes Res. Comm., 1954, Sect. 2.

Christie, W. J. 1955. Report on Lake Ontario investigations, 1954. Append. No. 21 in Annu. rep. to the Great Lakes Comm., 1954.

Christie, W. J. 1963. Effect of artificial propagation and weather on recruitment in Lake Ontario whitefish. J. Fish. Res. Board Can. 20(3):597-646.

Christie, W. J. 1972. Lake Ontario: Effects of exploitation, introductions, and eutrophication on the salmonid community. J. Fish. Res. Board Can. 29(6):913-929.

Christie, W. J. 1973. A review of the changes in the fish species composition of Lake Ontario. Great Lakes Fish. Comm. Tech. Rep. No. 23.

Christie, W. J., and H. A. Regier. 1973. Temperature as a major factor influencing reproductive success of fish--two examples. Rapp. P.V. Reun. Cons. Int. Explor. Mer. 164:208-218.

Cima, G. P. 1978. Annual interpretive report on the fish egg and larvae sampling program in Lake Michigan near Zion and Waukegan Generating Stations, 1977. Rep. to Commonwealth Edison Co., Chicago.

Cima, G. P., and M. Cochran. undated. Fish egg and larvae study. Pages 123-169 in Operational Environmental Monitoring in Lake Michigan near Zion Station July 1973 through December 1973, vol. III. By Industrial Bio-Test Laboratories, Inc. Semi-annu. rep. to Commonwealth Edison Co.

Cima, G. P., M. Cochran, and M. Kitchel. 1976. Annual interpretive report on fish eggs and larvae in Lake Michigan near Zion and Waukegan Generating Stations, 1975. Append. A *in* Compilation of reports relating to entrainment and impingement studies at Zion Generating Station, 1976, Volume I by NALCO Environmental Sciences.

Clady, M. D. 1966. Changes in exploited populations of cisco, *Coregonus artedii*. Pap. Mich. Acad. Sci. Arts Lett. 52:85-99.

Clady, M. D. 1970. Regulation of fish populations in three lightly exploited lakes in northern Michigan. Ph.D. Thesis, Univ. Mich.

Clady, M. D. 1976. Influence of temperature and wind on the survival of early stages of yellow perch, *Perca flavescens*. J. Fish. Res. Board Can. 33(9):1887-1893.

Clady, M. D. 1977. Distribution and relative exploitation of yellow perch tagged on spawning grounds in Oneida Lake. N.Y. Fish Game J. 24(2):168-177.

Clady, M. D., and B. Hutchinson. 1975. Effect of high winds on eggs of yellow perch, *Perca flavescens*, in Oneida Lake, New York. Trans. Am. Fish. Soc. 104(3):524-525.

Clapp, A. 1929. Some experiments in rearing channel catfish. Trans. Am. Fish. Soc. 59:114-117.

Clark, C. F. 1950. Observations on the spawning habits of the northern pike, *Esox lucius*, in northwestern Ohio. Copeia 1950(4):285-288.

Clark, C. F. 1956. Sandusky River report. Ohio Div. Wildl.

Clark, F. N. 1886. Report of operations at the Northville and Alpena stations during the season of 1884-85. Rep. U.S. Comm. Fish Fish. 12(1884):151-167.

Clark, F. N. 1910. A plan for promoting the whitefish production of the Great Lakes. Bull. U.S. Bur. Fish. 28(1):635-642.

Clark, F. N., and S. Bower. 1883. On the propriety of depositing whitefish minnows off the Harbor of Cleveland, Ohio. Bull. U.S. Fish. Comm. 3:349-352.

Clark, F. W., and M. H. A. Keenleyside. 1967. Reproductive isolation between the sunfish (*Lepomis gibbosus*) and *L. macrochirus*. J. Fish. Res. Board Can. 24(3):495-514.

Clemens, H. P. 1951. The growth of the burbot *Lota lota maculosa* (LeSueur) in Lake Erie. Trans. Am. Fish. Soc. 80(1950):163-173.

Clemens, H. P., and K. E. Sneed. 1957. The spawning behavior of the channel catfish (*Ictalurus punctatus*). U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. No. 219.

Clemens, W. A. 1922. A study of the ciscoes of Lake Erie. Univ. Toronto Stud., Publ. Ont. Fish. Res. Lab 2(Biol. Ser. No. 20):27-37.

Cleveland Electric Illuminating Company. 1973. Perry Nuclear Power Plant, Units 1 and 2, environmental report, construction permit stage, Vol. IV.

Cleveland Environmental Research Group. undated. Results of fisheries investigations in the Huron and Rocky Rivers, Ohio, 1976, final report. Prep. by U.S. Army Corps of Eng., Buffalo Dist.

Cleveland Environmental Research Group. 1976. Field survey of Vermilion Harbor, July 1975. Pages E-1 through E-28, Append. E, in Final Environmental Impact Statement, Operation and Maintenance, Vermilion Harbor, Erie County, Ohio. Prep. for U.S. Army Corps of Eng. Buffalo Dist.

Clifford, H. F. 1972. Downstream movements of white sucker, Catostomus commersoni, fry in a brown water stream of Alberta. J. Fish. Res. Board Can. 29(7):1091-1093.

Cloern, J. E. 1973. The survival of coho salmon (Oncorhynchus kisutch) eggs in two Wisconsin tributaries of Lake Michigan. M.S. Thesis, Univ. Wis.-Milwaukee.

Cloern, J. E. 1976. The survival of coho salmon (Oncorhynchus kisutch) eggs in two Wisconsin tributaries of Lake Michigan. Am. Midl. Nat. 96(2):451-461.

Cobb, E. W. 1922. Propagation and distribution of fish. Bienn. rep. State Game Fish Comm. Minn. For the Bienn. period ending June 30, 1922.

Cobb, E. W. 1923. Pike-perch propagation in northern Minnesota. Trans. Am. Fish. Soc. 53:95-105.

Coberly, C. E., and R. M. Horrall. 1980a. A strategy for re-establishing self-sustaining lake trout stocks in Illinois waters of Lake Michigan. Univ. Wis. Mar. Stud. Cent. Rep. No. 42.

Coberly, C. E., and R. M. Horrall. 1980b. Fish spawning grounds in Wisconsin waters of the Great Lakes as identified by eighty-five commercial fishermen (draft). Univ. Wis. Mar. Stud. Cent. Sea Grant Inst.

Coble, D. W. 1967. The white sucker population of South Bay, Lake Huron, and effects of the sea lamprey on it. J. Fish. Res. Board Can. 24(10):2117-2136.

Cochran, M. C. undated. Fish study. Pages 307-501, Chapt. 9, in Environmental monitoring in Lake Michigan near Zion and Waukegan Generating Stations, January 1972 through December 1972, Volume II, by Industrial Bio-Test Laboratories, Inc.

Cochran, M. C. 1976. Adult fish study. Pages 83-298 in Operational environmental monitoring in Lake Michigan near Zion Station, July 1975 through June 1976, Volume VI. NALCO Environmental Sciences.

Cochran, M. C., and G. Cima. 1974. Larval fish study. Pages 201-284 in Operational environmental monitoring in Lake Michigan near Zion Station, July 1973 through June 1974, Vol. III. Annu. Rep. to Commonwealth Edison Company by Industrial Bio-Test Laboratories, Inc.

Cochran, M. C., and M. Kitchel. 1976. Fish impingement at Zion Station January-December 1975. Append. A in Compilation of reports relating to entrainment and impingement studies at Zion Generating Station, 1976, Volume I by NALCO Environmental Sciences.

Coggeshall, L. T. 1924. A study of the productivity and breeding habits of the bluegill, Lepomis pallidus (Mitchell). Proc. Ind. Acad. Sci. 33(1923):315-320.

Coker, R. E. 1930. Studies of common fishes of the Mississippi River at Keokuk. Bull. U.S. Bur. Fish. 45:141-225.

Colby, P. J., and L. T. Brooke. 1969. Cisco (Coregonus artedii) mortalities in a southern Michigan lake, July 1968. Limnol. Oceanogr. 14(6):958-960.

Colby, P. J., and L. T. Brooke. 1970. Survival and development of lake herring (Coreognus artedii) eggs at various incubation temperatures. Pages 417-428 in Biology of Coregonid Fishes, C. C. Lindsey and C. S. Woods, eds. Univ. Manitoba Press, Winnipeg, Canada.

Colby, P. J., and L. T. Brooke. 1973. Effects of temperature on embryonic development of lake herring (Coregonus artedii). J. Fish. Res. Board Can. 30(6):799-810.

Cole, L. J. 1905. German carp in the United States. U.S. Comm. Fish. Rep. for the year ending June 30, 1904: 523-641.

Cole, R. A. 1976. The impact of thermal discharge from the Monroe Power Plant on the aquatic community in western Lake Erie. Mich. State Univ. Inst. Water Res. Rep. No. 32.6. Presented as Vol. 2, Monroe Power Plant Thermal Discharge Demonstration, Detroit Edison Co.

Cole, R. A. 1978a. Larval fish distributions in southwestern Lake Erie near the Monroe Power Plant. U.S. Environ. Prot. Agency, EPA-600/3-78-069.

Cole, R. A. 1978b. Entrainment at a once-through cooling system on western Lake Erie. U.S. Environ. Prot. Agency, EPA-600/3-78-070.

Cole, V. W. 1951. Contributions to the life history of the redear sunfish (Lepomis microlophus) in Michigan waters. M.S. Thesis, Mich. State Univ.

Colgan, P., and D. Ealey. 1973. Role of woody debris in nest site selection by pumpkinseed sunfish, Lepomis gibbosus. J. Fish. Res. Board Can. 30(6):853-856.

Collins, J. D. 1885. Propagation of the salmon in the Salmon River, Oswego County, New York. Bull. U.S. Fish. Comm. 5:287-288.

Collins, J. J. 1971. Introduction of kokanee salmon (Oncorhynchus nerka) into Lake Huron. J. Fish. Res. Board Can. 28(12):1857-1871.

Collins, J. J. 1975a. An emergent fry trap for lake spawning salmonines and coregonines. Prog. Fish Cult. 37(3):140-142.

Collins, J. J. 1975b. Occurrence of pink salmon (Oncorhynchus gorbuscha) in Lake Huron. J. Fish. Res. Board Can. 32(3):402-404.

Collinson, C., R. D. Norby, and A. K. Hansel. 1979. Continued evaluation of silurian reefs in Lake Michigan as potential breeding sites for lake trout. Prep. by Ill. State Geolog. Surv. for Ill. Coastal Zone Manage. Program.

Colvin, M. A. 1975. The walleye population and fishery in the Red Cedar River, Wisconsin. M.S. Thesis, Univ. Wis.-Stevens Point.

Commercial Fisheries Review. 1961a. Lake Erie fish population survey for 1961 season begins. 23(6):23-24.

Commercial Fisheries Review. 1961b. Hatch and survival in 1961, fair for many species in Lake Erie. 23(10):17-18.

Commonwealth Associates, Inc. 1979. Preliminary report of ecological studies at the West Lorain Plant, Lorain County, Ohio, April-October 1979 (R-2095), Vol. II--Aquatic Ecology. Prep. for Ohio Edison Co.

Commonwealth Edison Company. 1976. Summary report, Zion 316(b) studies. Appendix A in Compilation of reports relating to entrainment and impingement studies at Zion Generating Station, 1976, Volume I, by NALCO Environmental Sciences.

Consumers Power Company. 1972a. A study of the effects of installing and operating a large pumped storage project on the shores of Lake Michigan near Ludington, Michigan. Rep., January 1972.

Consumers Power Company. 1972b. Environmental impact of plant operation up to July 1, 1972. Palisades Plant, Spec. Rep.

Consumers Power Company. 1973a. Palisades Plant Semiannual Operations Report No. 4, July 1-December 31, 1972.

Consumers Power Company. 1973b. Palisades Plant Semiannual Operations Report No. 5, January 1-June 30, 1973.

Consumers Power Company. 1974. Palisades Plant Semiannual Operations Report No. 6, July 1-December 31, 1973.

Consumers Power Company. 1975. Summary of the effects of once-through cooling at the Palisades Nuclear Power Plant.

Consumers Power Company. 1976a. Section 316(b) intake study, J.R. Whiting Plant.

Consumers Power Company. 1976b. Section 316(b) intake study, J. H. Campbell Plant--Units No. 1 and 2.

Consumers Power Company. 1976c. Section 316(b) intake study, D. E. Karn Plant--Units 1 and 2.

Consumers Power Company. 1976d. Section 316(b) intake study, J. C. Weadock Plant.

Consumers Power Company. 1976e. Section 316(b) intake study, Big Rock Nuclear Plant.

Consumers Power Company. 1976f. Section 316(b) intake study, B. C. Cobb Plant.

Consumers Power Company. 1976g. Section 316(b) intake study, Palisades Nuclear Plant.

Consumers Power Company. 1977. Environmental report supplement, J. H. Campbell Plant Unit 3.

Cook, A. B. 1940. Helping nature . . . Mich. Conserv. 9(8):4.

Cook, A. B. 1961. Fish division. Mich. Dep. of Conserv. 20th Bienn. Rep. 1959-1960.

Cook, A. B. 1962. Fish division. Mich. Dep. of Conserv. 21st Bienn. Rep. 1961-1962.

Cook, W. A. 1929. A brief summary of work of the Bureau of Fisheries in the Lake Superior region. Trans. Am. Fish. Soc. 59:56-62.

Cooper, G. P. 1935. Some results of forage fish investigations in Michigan. Trans. Am. Fish. Soc. 65:132-142.

Cooper, G. P. 1938. Studies on the propagation, breeding habits and growth of certain forage fishes of eastern North America: a contribution to forage fish management. Ph.D. Thesis, Univ. Mich.

Cooper, J. E. 1978. Eggs and larvae of the logperch, Percina caprodes (Rafinesque). Am. Midl. Nat. 99(2):257-269.

Cooper, J. E. 1979. Description of eggs and larvae of fantail (Etheostoma flabellare) and rainbow (Etheostoma caeruleum) darters from Lake Erie tributaries. Trans. Am. Fish. Soc. 108(1):46-56.

Cooper, J. E. 1980. Egg, larval and juvenile development of longnose dace, Rhinichthys cataractae, and river chub, Nocomis micropogon, with notes on their hybridization. Copeia 1980(3):469-478.

Copes, F. C. 1978. Ecology of the creek chub. Rep. Fauna Flora Wis. 12:1-21.

Coventry, A. F. 1922. Breeding habits of the land-locked sea lamprey (Petromyzon marinus var. Dorsatus Wilder). Publ. Ont. Fish. Res. Lab. 9:127-136.

Craig, R. E. 1976. The Niagara River maskinonge (Esox masquinongy). Ont. Min. Nat. Resour.

Creaser, C. W. 1925. The establishment of the Atlantic smelt in the upper waters of the Great Lakes. Mich. Acad. Arts Lett. 5:405-424.

Creaser, C. W. 1930. The development of smelt runs in Lake Charlevoix with a summary of the smelt situation in Michigan. Mich. Dep. Conserv. Inst. Fish Res. Rep. No. 11.

Creaser, C. W. 1932a. Atlantic smelt in Great Lakes. The Fisherman 1(9):3-4,11.

Creaser, C. W. 1932b. The lamprey Petromyzon marinus in Michigan. Copeia 1932(3):157.

Cross, F. B. 1950. Effects of sewage and of a headwaters impoundment on the fishes of Stillwater Creek in Payne County, Oklahoma. Am. Midl. Nat. 43(1):128-145.

Cross, J. E. 1964. Walleye distribution and movements in Berlin Reservoir, Ohio. Ohio Dep. Nat. Resour. Div. Wildl. Publ. W-337.

Crossman, E. J. 1962. The grass pickerel, Esox americanus vermiculatus LeSueur, in Canada. Roy. Ont. Mus. Univ. Toronto, Life Sci. Div. Contrib. 55.

Crossman, E. J. 1976. Quetico fishes. R. Ont. Mus., Toronto.

Crossman, E. J., and W. F. Hadley. 1977. The fishes and fisheries of the Niagara River. Abstract, 20th Conf. on Great Lakes Research.

Crossman, E. J., and C. D. Goodchild. 1978. An annotated bibliography of the muskellunge, Esox masquinongy (Osteichthyes:Salmoniformes). Life Sci. Misc. Publ., R. Ont. Mus.

Crossman, E. J., and H. D. Van Meter. 1979. Annotated list of the fishes of the Lake Ontario watershed. Great Lakes Fish. Comm. Tech. Rep. No. 36.

Crowe, J. A. O. 1979a. State salmon start run. Detroit News, Aug. 30, 1979.

Crowe, J. A. O. 1979b. The day a salmon hit. Detroit News, October 21, 1979.

Crowe, W. R. 1955. Numerical abundance and use of a spawning run of walleyes in the Muskegon River, Michigan. Trans. Am. Fish. Soc. 84:125-136.

Crowe, W. R. 1962. Homing behavior in walleyes. Trans. Am. Fish. Soc. 91(4):350-354.

Crowe, W. R. 1964. Walleyes in Bay de Noc. State of Mich., Job Completion Rep., Dingell-Johnson Proj. No. F-27-R-2, July 1, 1963 to June 30, 1964.

Crowe, W. R., E. Karvelis, and L. S. Joeris. 1963. The movement, heterogeneity, and rate of exploitation of walleyes in northern Green Bay, Lake Michigan, as determined by tagging. Int. Comm. NW Atl. Fish. Spec. Publ. No. 4:38-41.

Cucin, D., and H. A. Regier. 1966. Dynamics and exploitation of lake whitefish in southern Georgian Bay. J. Fish. Res. Board Can. 23(2):221-274.

Cuerrier, J-P. 1945. Recherches sur la biologie de l'esturgeon du Saint-Laurent superieur. Manuscript: 1-13, Prov. Office of Biology, Min. Game Fish, Quebec.

Cuerrier, J-P. 1946. L'esturgeon du Saint-Laurent superieur. Les Cercles des jeunes Naturalistes, Chronique No. 166. Montreal Le Devoir: 9.

Curry, K. D., and A. Spacie. 1979. The importance of tributary streams to the reproduction of catostomids and sauger. Purdue Univ. Water Resour. Res. Center Tech. Rep. No. 126.

Curtis, B. 1949. The warm-water game fishes of California. Calif. Fish Game 35(4):255-273.

Dahl, F. H., and R. B. McDonald. 1980. Effects of control of the sea lamprey (*Petromyzon marinus*) on migratory and resident fish populations. Can. J. Fish. Aquat. Sci. 37(11):1886-1894.

Daiber, F. C. 1950. The life history and ecology of the sheepshead, *Aplodinotus grunniens* Rafinesque, in western Lake Erie. Ph.D. Thesis, Ohio State Univ.

Daiber, F. C. 1952. The food and feeding relationships of the freshwater drum, *Aplodinotus grunniens* Rafinesque, in western Lake Erie. Ohio J. Sci. 52(1):35-46.

Daiber, F. C. 1953. Notes on the spawning population of the freshwater drum (*Aplodinotus grunniens* Rafinesque) in western Lake Erie. Am. Midl. Nat. 50(1):159-171.

Daly, R. 1954. Movement of tagged walleyes in Chequamegon Bay. Wis. Conserv. Dep. Fish Abstr. No. 11.

Daly, R. 1968a. Preliminary notes on management of the rainbow trout in western Lake Michigan. Wis. Dep. Nat. Resour., Fish Manage. Div., Oshkosh, mimeo.

Daly, R. 1968b. Progress report of fish management on Lake Michigan 1968. Wis. Conserv. Dep., Fish Manage. Div., Oshkosh.

Daly, R. 1974. Preliminary report--Mink River Estuary. Wis. Dep. Nat. Resour.

Daly R. 1977. Yellow perch in southern Green Bay. Append. X, Pages 67-75 *in* Minutes (with append.) of Lake Michigan Comm. 1977 Annu. Meeting, Great Lakes Fish. Comm.

Daly, R., V. A. Hacker, and L. Wiegert. 1962. The lake trout: its life history, ecology, and management. Wis. Conserv. Dep. Publ. No. 233.

Daly, R., J. Moore, and P. Schultz. 1975. Status of fish stocks, Lake Michigan. Pages 67-96, Append. V(B), *in* Minutes (with append.) of Lake Michigan Comm., 1975 Annu. Meet., Great Lakes Fish. Comm.

Dames and Moore. 1978. Assessment of fisheries resource and impacts for the Sault Ste. Marie deep water harbour project. Prep. for Can. Dep. Publ. Works.

Davidson, M. H. 1937. Notes on the whitefish (*Coregonus clupeaformis*). Turtox News 15(8):98-99.

Davis, C. C. 1959. Damage to fish fry by cyclopoid copepods. Ohio J. Sci. 59(2):101-102.

Davis, C. C. 1959. A planktonic fish egg from fresh water. Limnol. Oceanogr. 4(3):352-355.

Davis, W. A., W. P. Shera, and J. G. Weise. 1974. Individual stream treatment reports, Canadian side of Lake Ontario, 1973. Pages 47-52, Append. 11, *in* Annu. Rep. 1973 (GRL/A-73) of the Sea Lamprey Control Centre, Sault Ste. Marie, Ontario, to the Great Lakes Fish. Comm., of activities carried out under a Memorandum of Agreement during the period April 1, 1973 to March 31, 1974.

Davis, W. A., W. P. Shera, and J. G. Weise. 1975a. Stream treatment reports, Lake Huron, 1974. Pages 26-39, Append. 7, *in* Annu. Rep. 1974 (GRL/A-74) of the Sea Lamprey Control Centre, Sault Ste. Marie, Ontario, to the Great Lakes Fish. Comm., of activities carried out under a Memorandum of Agreement during the period April 1, 1974 to March 31, 1975.

Davis, W. A., W. P. Shera, and J. G. Weise. 1975b. Stream treatment reports, Canadian side of Lake Ontario, 1974. Pages 39-51, Append. 8, *in* Annu. Rep. 1974 (GRL/A-74) of the Sea Lamprey Control Centre, Sault Ste. Marie, Ont., to the Great Lakes Fish. Comm. of activities carried out under a Memorandum of Agreement during the period April 1, 1974 to March 31, 1975.

Dean, B. 1895. The early development of gar-pike and sturgeon. J. Morph. 11:1-62.

Dean, B. 1896. The early development of Amia. J. Micr. Sci. 38(152):413-444.

Dean, B. 1899. On the dogfish (*Amia calva*), its habits and breeding. 4th Annu. Rep. N.Y. Comm. Fish., Game, For.:246-256.

Dean, E. L. 1972. The reproductive biology of the longnose gar (*Lepisosteus osseus* L.) in Lake St. Clair. M.S. Thesis, Univ. Guelph.

Deason, H. J. 1936. Morphometric and life history studies of the pike-perches (*Stizostedion*) of Lake Erie. Ph.D. Thesis, Univ. Mich.

Deason, H. J. 1933. Preliminary report on the growth rate, dominance, and maturity of the pike-perches (*Stizostedion*) of Lake Erie. Trans. Am. Fish. Soc. 63:348-360.

Deason, H. J., and R. Hile. 1947. Age and growth of the kiyi, *Leucichthys kiyi* Koelz, in Lake Michigan. Trans. Am. Fish. Soc. 74(1944):88-142.

DeBoer, M. J., and J. R. Williams. 1954. Meet Mr. "Musky." Mich. Conserv. 23(4):12-15.

Dees, L. J. 1980. Sea lamprey. U.S. Fish Wildl. Serv. Fish. Leaf. 580.

Delisle, C., and W. Van Vliet. 1968. First records of the sculpins, *Myoxocephalus thompsonii* and *Cottus ricei*, from the Ottawa Valley, southwestern Quebec. J. Fish. Res. Board Can. 25(12):2733-37.

Delisle, G. E. 1962. Water velocities tolerated by spawning kokanee salmon. Calif. Fish Game 48(1):77-78.

Detroit Edison Co. 1975. Unpublished data sheets (entrainment).

Detroit Edison Co. 1976a. St. Clair Power Plant--study report on cooling water intake.

Detroit Edison Co. 1976b. Conners Creek Power Plant--study report on cooling water intake.

Detroit Edison Co. 1976c. Delray Power Plant--study report on cooling water intake.

Detroit Edison Co. 1976d. River Rouge Power Plant--study report on cooling water intake.

Detroit Edison Co. 1976e. Trenton Channel Power Plant--study report on cooling water intake.

Detroit Edison Co. 1976f. Marysville Power Plant--study report on cooling water intake.

Detroit Edison Co. 1976g. Enrico Fermi Power Plant No. 1--study report on cooling water intake.

Detroit Edison Co. 1976h. Monroe Power Plant--study report on cooling water intake.

Detroit Edison Co. 1978. 1977 Annual Report of the aquatic ecological program at the Enrico Fermi Plant. Append. 2C in Applicant's Environ. Rep., Vol. 1, Operating License Stage, Enrico Fermi Atomic Power Plant Unit 2.

DeVore, P. W. 1978. Fishery resources of the Superior-Duluth Estuary. Prep. by Center for Lake Superior Environ. Studies, Univ. Wis.-Superior for Metropolitan Interstate Comm.

DeVore, P. W., L. T. Brooke, and W. A. Swenson. 1978. The effects of red clay turbidity and sedimentation on aquatic life in the Nemadji River system. Pages 97-120 in Conf. on voluntary and regulatory approaches for nonpoint source pollution control (EPA-905/9-78-001), May 22-23, 1978.

Doan, K. H. 1938a. Observations dogfish (Amia calva) and their young. Copeia 1938(4):204.

Doan, K. H. 1938b. Studies of the small-mouthed black bass in Ontario. M.S. Thesis, Univ. Toronto.

Doan, K. H. 1939. Growth of bass fry. Copeia 1939(2):81-87.

Doan, K. H. 1940. Studies of the smallmouth bass. J. Wildl. Manage. 4(3):241-266.

Doan, K. H. 1941. Relation of sauger catch to turbidity in Lake Erie. Ohio J. Sci. 41(6):449-452.

Doan, K. H. 1942a. The nesting of smallmouth bass in Lake Erie from 1938 to 1941. Ohio Conserv. Bull. 6(5):31-32.

Doan, K. H. 1942b. Some meteorological and limnological conditions as factors in the abundance of certain fishes in Lake Erie. Ecol. Monogr. 12:293-314.

Dobie, J., O. L. Meehean, S. F. Snieszko, and G. N. Washburn. 1956. Raising bait fishes. U.S. Fish Wildl. Serv. Circ. 35.

Dodge, D. P. 1972. Comparative bio-ecology of rainbow trout (Salmo gairdneri Richardson), of three tributaries to the Owen Sound, Lake Huron. Ph.D. Thesis, Univ. Guelph.

Dodge, D. P., and H. R. MacCrimmon. 1970. Vital statistics of a population of Great Lakes rainbow trout (Salmo gairdneri) characterized by an extended spawning season. J. Fish. Res. Board Can. 27(3):613-618.

Dodge, D. P., and H. R. MacCrimmon. 1971. Environmental influences on extended spawning of rainbow trout (Salmo gairdneri). Trans. Am. Fish. Soc. 100(2):312-318.

Dombeck, M. P. 1979. Movement and behavior of the muskellunge determined by radiotelemetry. Wis. Dep. Nat. Resour. Tech. Bull. No. 113.

Doremus, S. D. 1975. Comments on draft environmental statement. Page A-13 in U.S. Nucl. Reg. Comm., Final Environ. Statement related to construction of Davis-Besse Nuclear Power Station Units 2 and 3, Docket Nos. 50-500 and 50-501.

Dorr, J. A. III. 1976. Visual observations of the intake and discharge structures and control areas. Append. A-1 in Environmental Operating Report, Indiana and Michigan Power Co., Donald C. Cook Nuclear Plant Unit 1, July 1, 1975 through December 31, 1975.

Dorr, J. A. III. 1977. Visual observations of the intake and discharge structures. Append. A in Environ. Operating Rep., Indiana and Mich. Power Co., Donald C. Cook Nuclear Plant Unit 1, July 1, 1976 through December 31, 1976.

Downing, S. W. 1904. The whitefish: some thoughts on its propagation and protection. Trans. Am. Fish. Soc. 33:104-110.

Downing, S. W. 1905. Collecting, hatching and distribution of pike-perch: why the great loss of eggs. Trans. Am. Fish. Soc. 34:239-255.

Downing, S. W. 1910. A plan for promoting the whitefish production of the Great Lakes. Bull. U.S. Bur. Fish. 28:629-633.

Downing, S. W. 1923. Are we maintaining the supply of whitefish in Lake Erie? Trans. Am. Fish. Soc. 53:62-64.

Dryer, W. R. 1963. Age and growth of the whitefish in Lake Superior. U.S. Fish Wildl. Serv. Fish. Bull. 63(1):77-95.

Dryer, W. R. 1964. Movements, growth, and rate of recapture of whitefish tagged in the Apostle Island area of Lake Superior. U.S. Fish Wildl. Fish. Bull. 63(3):611-618.

Dryer, W. R. 1966. Bathymetric distribution of fish in the Apostle Islands region, Lake Superior. Trans. Am. Fish. Soc. 95(3):248-259.

Dryer, W. R., and J. Beil. 1964. Life history of lake herring in Lake Superior. U.S. Fish Wildl. Serv. Fish. Bull. 63(3):493-530.

Dryer, W. R., and J. Beil. 1968. Growth changes of the bloater (*Coregonus hoyi*) of the Apostle Islands region of Lake Superior. Trans. Am. Fish. Soc. 97(2):146-158.

Dryer, W. R., and G. R. King. 1968. Rehabilitation of lake trout in the Apostle Islands region of Lake Superior. J. Fish. Res. Board Can. 25(7):1377-1403.

Dunford, W. E. 1975. Aquatic biological studies, Darlington GS, 1975. Ont. Hydro Res. Div. Rep. No. 75-367-H.

Dunford, W. E. 1976a. Pickering biological report--year II postoperational study. Ont. Hydro Res. Div. Rep. No. 76-315-K.

Dunford, W. E. 1976b. Aquatic biology commissioning study, Lennox GS, 1975. Ont. Hydro Res. Div. Rep. No. 76-408-K.

Dunford, W. E. 1976c. Aquatic biological studies--Darlington GS, 1975. Ont. Hydro Res. Div. Rep. No. 76-174-K.

Dunford, W. E. 1977. Larval fish entrainment at Pickering GS, 1976. Ont. Hydro Res. Div. Rep. No. 77-152-K.

Dunford, W. E. 1978a. Field fish spawning study, Lennox GS, 1976. Ont. Hydro Res. Div. Rep. 78-28-K.

Dunford, W. E. 1978b. Field fish spawning, BNPD, 1977, interim progress report--once through cooling. Ont. Hydro Res. Div. Rep. No. C78-9-K.

Dunford, W. E. 1978c. Whitefish spawning study Darlington GS, 1977. Ont. Hydro Res. Div. Rep. No. 78-48-K.

Dunford, W. E. 1978d. Effects of a thermal discharge on the growth of brown bullheads. Ont. Hydro Res. Div. Rep. No. 78-198-K.

Dunford, W. E. 1979. Progress report: field fish spawning studies, 1978, once-through cooling studies. Ont. Hydro Res. Div. Rep. No. C79-46-K.

Dunn, C. A. 1918. The Lake Superior herring. Trans. Am. Fish. Soc. 47(3):92-95.

Dunning, D. J. 1979. St. Lawrence River fisheries study--The environmental evaluation work group FY 1979 studies of the winter navigation demonstration program.

Dunning, D., J. T. Evans, and M. J. Tarby. undated. Baseline biological studies preparatory to the assessment of winter navigation: fisheries data base on the St. Lawrence River. N.Y. State Dep. Environ. Conserv.

Dunning, D. J., M. J. Tarby, and J. T. Evans. 1978. Adult fisheries study. Tech. rep. D in Environ. assessment, FY 1979 winter navigation demonstration on the St. Lawrence River, Tech. reps.: Vol. I.

Dunstall, T. G. 1978a. Larval fish entrainment at Bruce GS 'A', 1977. Ont. Hydro Res. Div. Rep. No. 78-192-K.

Dunstall, T. G. 1978b. Larval fish entrainment at Pickering GS. Ont. Hydro Res. Div. Rep. No. 78-322-K.

Dunstall, T. G. 1979a. Distribution of pelagic fish along the north shore of Lake Ontario, progress report. Ont. Hydro Res. Div. Rep. No. C79-26-K.

Dunstall, T. G. 1979b. Distribution of pelagic larval fish along the north shore of Lake Ontario--1978 interim report. Ont. Hydro Res. Div. Rep. No. 79-405-K.

Dunstall, T. G. 1979c. Entrainment of alewife larvae--Lakeview GS. Ont. Hydro Res. Div. Rep. No. C79-24-K.

Dustin, S. M. 1975. Summary of surveys and lampricide treatments on the St. Marys River, 1971-74. Append. 18, pages 91-93, in Annu. rep. 1974 (GRL/A-74) of the Sea Lamprey Control Centre, Sault Ste. Marie, Ontario, to the Great Lakes Fish. Comm. of activities carried out under a Memorandum of Agreement during the period April 1, 1974 to March 31, 1975.

Dymond, J. R. 1922. A provisional list of the fishes of Lake Erie. Univ. Toronto Stud., Publ. Ont. Fish. Res. Lab. No. 4.

Dymond, J. R. 1926. The fishes of Lake Nipigon. Univ. Toronto Stud., Publ. Ont. Fish. Res. Lab. No. 27.

Dymond, J. R. 1928. Some factors affecting the production of lake trout (Cristivomer namaycush) in Lake Ontario. Univ. Toronto Stud., Publ. Ont. Fish. Res. Lab. No. 33:27-41.

Dymond, J. R. 1931. The small-mouthed black bass and its conservation. Ont. Dep. Game Fish., Biol. Fish Cult. Br. Bull. No. 2:1-10.

Dymond, J. R. 1944. Spread of the smelt (Osmerus mordax) in the Canadian waters of the Great Lakes. Can. Field Nat. 58(1):12-14.

Dymond, J. R. 1964. The fisheries of the Great Lakes. Pages 73-91, Chapt. VII, in Fish and Wildlife, a memorial to W. J. K. Harkness, J. R. Dymond, ed. Longmans Canada Ltd., Toronto.

Dymond, J. R., J. L. Hart, and A. L. Pritchard. 1929. The fishes of the Canadian waters of Lake Ontario. Univ. Toronto Studies, Publ. Ont. Fish. Res. Lab. No. 37, Biol. Ser. No. 33.

Eaton, E. H. 1928. The Finger Lakes fish problem. Pages 40-66 in A Biological Survey of the Oswego River System. Suppl. to 17th Annu. Rep. (1927), State of N.Y. Conserv. Dep., Albany.

Echelle, A. A. 1967. The food habits of young-of-the-year gars (Lepisosteus) in Lake Texoma, with notes on spawning and development. M.S. Thesis, Univ. Okla.

Echelle, A. A., and C. D. Riggs. 1972. Aspects of the early life history of gars (Lepisosteus) in Lake Texoma. Trans. Am. Fish. Soc. 101(1):106-112.

Eckert, T. H., and J. R. Hanlon. 1977. Fisheries studies along the St. Lawrence River. Pages 61-90 in Preliminary report: biological characteristics of the St. Lawrence River, J. W. Geis, ed.

Eco Research, Inc. 1978. Fish tagging study 1972-1977; for Power Authority of the State of New York.

Eddy, S., and J. C. Underhill. 1974. Northern fishes. Univ. Minn. Press, Minneapolis.

Edminster, J. O. 1940. The fish and fisheries of Sandusky Bay. M.S. Thesis. Ohio State Univ.

Edmunds, M. C. 1874. Obstructions in the tributaries of Lake Champlain. U.S. Fish. Comm. Rep. 2:622-629.

Edsall, T. A. 1964. Feeding by three species of fishes on the eggs of spawning alewives. Copeia 1964(1):226-227.

Edsall, T. A. 1967. Biology of the freshwater drum in western Lake Erie. Ohio J. Sci. 67(6):321-340.

Edsall, T. A. 1970a. Effect of temperature on the rate of development and survival of alewife eggs and larvae. Trans. Am. Fish. Soc. 99(2):376-380.

Edsall, T. A. 1970b. A hermaphroditic coregonine from Lake Michigan. Trans. Am. Fish. Soc. 99(3):611.

Edsall, T. A. 1971. Fishery resources of the coastal zone waters of the Great Lakes. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab. Presented at Coastal Zone Manage. Conf., Traverse City, MI.

Edsall, T. A., and P. J. Colby. 1970. Temperature tolerance of young-of-the-year cisco, Coregonus artedii. Trans. Am. Fish. Soc. 99(3):526-531.

Edsall, T. A., and D. V. Rottiers. 1976. Temperature tolerance of young-of-the-year lake whitefish, Coregonus clupeaformis. J. Fish. Res. Board Can. 33(1):177-180.

Edsall, T. A., D. V. Rottiers, and E. H. Brown. 1970. Temperature tolerance of bloater (Coregonus hoyi). J. Fish. Res. Board Can. 27(11):2047-2052.

Edsall, T. A., and M. I. Saxon. 1968. Two hermaphroditic alewives from Lake Michigan. Copeia 1968(2):406-407.

Eigenmann, C. H. 1896. Fishes. Proc. Ind. Acad. Sci. (1895):252-257.

Eigenmann, C. H. 1902. The solution of the eel question. Trans. Am. Micro. Soc. 23:5-18.

Eipper, A. W. 1964. Growth, mortality rates, and standing crops of trout in New York farm ponds. Memoir 388, Cornell Agric. Exper. Stn., N.Y. State Coll. Agric., Ithaca, N.Y.

Eisele, P. J., and J. F. Malaric. 1977. A conceptual model of causal factors regarding gizzard shad runs at steam electric power plants. Pages 291-298 in Fourth National Workshop on entrainment and impingement, Loren D. Jensen, ed.; EA Communications.

Elliot, C. (ed.). 1942. Fading trails: the story of endangered American wildlife. The Macmillan Co., New York.

Ellis, M. M., and G. C. Roe. 1917. Destruction of log perch eggs by suckers. Copeia 1917(47):69-71.

El-Zarka, S. E-D. 1959. Fluctuations in the population of yellow perch, Perca flavescens (Mitchill), in Saginaw Bay, Lake Huron. U.S. Fish Wildl. Serv. Fish. Bull. 59:365-415.

Embody, G. C. 1914. The horned dace. Nature-study Review 10:168-174.

Embody, G. C. 1915. The farm fishpond. Country Life Ser. No. 3. The Cornell Reading Courses 4(94):213-252.

Embody, G. C. 1918. Artificial hybrids between pike and pickerel. J. Hered. 9:253-256.

Embody, G. C. 1922. Report upon a study of the fish producing waters of Tompkins County, N.Y. N.Y. Conserv. Comm., Albany.

Embody, G. C. 1928. Stocking policy for the streams, smaller lakes and ponds of the Oswego watershed. Pages 17-39 in A Biological Survey of the Oswego River System, Suppl. to 17th Annu. Rep. (1927). N.Y. Conserv. Dep., Albany.

Emery, A. R. 1973. Preliminary Comparisons of day and night habits of freshwater fish in Ontario lakes. J. Fish. Res. Board Can. 30(6):761-774.

Emery, Lee. 1976. Fish inhabiting U.S. waters of the Great Lakes, with indications of their relative abundance and of their importance as commercial, sport, or forage species. pp. 19-25 in Great Lakes fish egg and larvae identification (ed. J. Boreman), FWS/OBS-76/23.

Emery, L., and E. H. Brown. 1978. Fecundity of the bloater (Coreognus hoyi) in Lake Michigan. Trans. Am. Fish. Soc. 107(6):785-789.

Emond, G. A. Record of telephone conversation, Sept. 6, 1977.

Engel, S., and J. J. Magnuson. 1971. Ecological interactions between coho salmon and native fishes in a small lake. Proc. Conf. Great Lakes Res. 14:14-20.

Environment Canada. 1977a. Ecological sensitive area inventory for the lower Great Lakes watershed.

Environment Canada. 1977b. Ecological sensitive area inventory for the St. Lawrence and Ottawa Rivers watershed.

Environment Canada. 1977c. Ecological sensitive area inventory for the upper Great Lakes watershed.

Environmental Resource Associates. 1978. Fishery study of the Chagrin River mouth and Lake Erie near East Lake, Ohio: with temperature and oxygen profiles. Prep. for Cleveland Electric Illuminating Co.

Envirosphere Company. 1977a. Demonstration of best technology available for minimizing adverse environmental impact with respect to cooling water intake design, Lake Erie Generating Station, Niagara Mohawk Power Corp., Syracuse, N.Y.

Envirosphere Company. 1977b. Application to the New York State Board on Electric Generation Siting and the Environment for the Lake Erie Generating Station. Prep. for Niagara Mohawk Power Corp.

Erickson, J. G. 1952. Age and growth of the black and white crappies, Pomoxis nigro-maculatus (LeSueur) and P. annularis Rafinesque, in Clear Lake, Iowa. Iowa State J. Sci. 26(3):491-505.

Erkkila, L. F., B. R. Smith, and A. L. McLain. 1956. Sea lamprey control on the Great Lakes, 1953 and 1954. U.S. Fish Wildl. Serv. Spec. Sci. Rep. No. 175.

Ernest, J. R. 1960. The embryology and larval development of the northern rock bass, Ambioplites ruprestris ruprestris (Rafinesque). M.S. Thesis, Ohio State Univ.

Eschmeyer, P. H. 1949. Reproduction and migration of the yellow pike perch Stizostedion vitreum vitreum, in Michigan. Ph.D. Thesis, Univ. Mich.

Eschmeyer, P. H. 1950. The life history of the walleye, Stizostedion vitreum vitreum (Mitchill), in Michigan. Bull. Inst. Fish. Res. No. 3.

Eschmeyer, P. H. 1955. The reproduction of lake trout in southern Lake Superior. Trans. Am. Fish. Soc. 84(1954):47-74.

Eschmeyer, P. H. 1956. The early life history of the lake trout in Lake Superior. Mich. Dep. Conserv. Inst. Fish. Res. Misc. Publ. No. 10.

Eschmeyer, P. H. 1957a. Note on subpopulations of lake trout in the Great Lakes. U.S. Fish Wildl. Serv. Spec. Sci. Rep. No. 208.

Eschmeyer, P. H. 1957b. The near extinction of the lake trout in Lake Mountain. Trans. Am. Fish. Soc. 85:102-119.

Eschmeyer, P. H. 1964. The lake trout (Salvelinus namaycush). U.S. Fish Wildl. Serv. Fish. Leaf. 555.

Eschmeyer, P. H., and R. M. Bailey. 1955. The pygmy whitefish, Coregonus coulteri, in Lake Superior. Trans. Am. Fish. Soc. 84(1954):161-199.

Eschmeyer, P. H., and W. R. Crowe. 1955. The movement and recovery of tagged walleyes in Michigan 1929-1953. Mich. Dep. Conserv. Inst. Fish Res. Misc. Publ. No. 8.

Eschmeyer, P. H., R. Daly, and L. F. Erkkila. 1953. The movement of tagged lake trout in Lake Superior, 1950-1952. Trans. Am. Fish. Soc. 82(1952):68-77.

Euers, D. 1960. Smelt fishing in Wisconsin. Wis. Conserv. Bull. 25(4):1-4.

Everest, G. 1973. Some effects of heated effluents on fish populations at three thermal generating stations. M.S. Thesis, Univ. Toronto.

Evermann, B. W., and H. W. Clark. 1920. Lake Maxinkuckee: physical and biological survey. Ind. Dep. Conserv. Publ. No. 7, Vol. I, Part I.

Evermann, B. W., and W. C. Kendall. 1902a. An annotated list of the fishes known to occur in the St. Lawrence River. U.S Fish Comm. Rep. 27:227-240.

Evermann, B. W., and W. C. Kendall. 1902b. Notes on the fishes of Lake Ontario. Rep. U.S. Comm. Fish Fish. 27:209-216.

Evermann, B. W., and H. B. Latimer. 1910. The fishes of the Lake of the Woods and connecting waters. Proc. U.S. Natl. Mus. 39(1778):121-136.

Ewers, Lela A. 1933. Summary report of Crustacea used as food by the fishes of the western end of Lake Erie. Trans. Am. Fish. Soc. 63:379-390.

Eycleschymer, A. C. 1901. Observations of the breeding habits of Ameiurus nebulosus. Am. Nat. 35(419):911-918.

Eycleshymer, A. C. 1903. The early development of Lepisosteus osseus. Univ. Chicago Sec. Publ. Vol. 10.

Faber, D. J. 1963. Larval fish from the pelagial region of two Wisconsin lakes. Ph.D. Thesis, Univ. Wis.

Faber, D. J. 1964. A preliminary report on the 1964 study of larval fish in South Bay. Ont. Dep. Lands For., unpubl.

Faber, D. J. 1967. Limnetic larval fish in northern Wisconsin lakes. J. Fish. Res. Board Can. 24(5):927-937.

Faber, D. J. 1970. Ecological observations on newly hatched lake whitefish in South Bay, Lake Huron. Pages 481-500 in Biology of coregonid fishes, C. C. Lindsey and C. S. Woods, eds., Univ. of Manitoba Press, Winnipeg.

Fahy, W. E. 1954. The life history of the northern greenside darter, Etheostoma blennioides Rafinesque. J. Elisha Mitchell Sci. Soc. 70(2):139-205.

Ferguson, R. G. 1954. Lake Erie investigations, 1954. Append. No. 17, in Annu. Rep. to the Great Lakes Res. Comm., 1954, Sect. 2.

Ferguson, R. G. 1955. Lake Erie investigations, 1954. Append. No. 17 in Annu. Rep. to the Great Lakes Res. Comm., 1954.

Ferguson, R. G. 1957. Fish tagging studies in Lakes Erie, St. Clair, and Huron. Preliminary Rep., Ont. Dep. Lands For. Div. Res.

Ferguson R. G. 1965. Bathymetric distribution of American smelt in Lake Erie. Univ. Mich. Great Lakes Res. Div. Publ. 13:47-60.

Ferguson, R. G., and R. Cummins. 1956. Lake St. Clair fish tagging. Rep. to Lake Erie Fish Manage. Comm.

Ferguson, R. G., and A. J. Derkson. 1971. Migrations of adult and juvenile walleyes (Stizostedion vitreum vitreum) in southern Lake Huron, Lake St. Clair, Lake Erie, and connecting waters. J. Fish. Res. Board Can. 8(8):1133-1142.

Fish, M. 1929. Contributions to the early life histories of Lake Erie fishes. Pages 76-189 in A biological survey of the Erie-Niagara system. Suppl. to 18th Annu. Rep. (1928), N.Y. Conserv. Dep.

Fish, M. P. 1930. Contributions to the natural history of the burbot. Bull. Buffalo Soc. Nat. Sci. 15(1).

Fish, M. P. 1932. Contributions to the early life histories of sixty-two species of fishes from Lake Erie and its tributary waters. U.S. Bur. Fish. Bull. No. 47:293-398.

Fisheries Research Board of Canada. 1955. Great Lakes sea lamprey control investigation. Pages 73-76 in Annu. rep. of the Fish. Res. Board of Can. for the fiscal year ending March 31, 1955.

Fisheries Research Board of Canada. 1968. The status of lake trout stocks in the Ontario waters of Lake Superior. Append. II *in* Minutes of Lake Superior Comm. Annu. Meet., Great Lakes Fish. Comm.

Fisherman. 1936. Heavy losses of natural spawn shown in report. 5(11):1-2.

Fisherman. 1947. Survey of lamprey spawning continues in Wisconsin and Michigan. 15(5):6.

Fisherman. 1952. The four lampreys native to Wisconsin. 20(3):10-11.

Flittner, G. A. 1964. Morphometry and life history of the emerald shiner, *Notropis atherinoides* Rafinesque. Ph.D. Thesis, Univ. Mich.

Fluegel, W. 1978. The smelt of western Lake Superior. Lake Superior Basin Studies Center.

Foell, E. J. 1974. The age and growth of freshwater drum (*Aplodinotus grunniens* Rafinesque) from Lake Erie near Cleveland, Ohio. M.S. Thesis, John Carroll Univ.

Foerster, R. E. 1924. Studies in the ecology of the sockeye salmon (*Oncorhynchus nerka*). Ph.D. Thesis, Univ. Toronto.

Fogle, N. E. 1975. Michigan's oldest fish. Mich. Nat. Resour. 44(1):32.

Follett, R. 1932. *Salmo salar* of the St. Lawrence River. Trans. Am. Fish. Soc. 62:366-68.

Forbes, S. A., and R. E. Richardson. 1920. The fishes of Illinois (2nd ed.). Ill. Nat. Hist. Surv. Urbana, Ill.

Forney, J. L. undated. Production and behavior of muskellunge in a controlled marsh. State of N.Y. Job final rep., Proj. No. F-17-R-13, April 1, 1967-March 31, 1969.

Forney, J. L. 1953. Distribution and movement of marked walleyes in Oneida Lake, New York. Trans. Am. Fish. Soc. 92(1):47-52.

Forney, J. L. 1955. Life history of the black bullhead (*Ameiurus melas*) of Clear Lake, Iowa. Iowa State Coll. J. Sci. 30(1):145-162.

Forney, J. L. 1956. Propagation of bait fishes in New York farm ponds. Ph.D. Thesis, Cornell Univ.

Forney, J. L. 1963. Distribution and movement of marked walleyes in Oneida Lake, New York. Trans. Am. Fish. Soc. 92(1):47-52.

Forney, J. L. 1966. Factors affecting first-year growth of walleyes in Oneida Lake, New York. N.Y. Fish Game J. 13(2):146-167.

Forney, J. L. 1967. Utility of a small spawning impoundment for increasing northern pike production. N.Y. Job Completion Rep., Proj. No. P-17-R-11, April 1, 1966-March 31, 1967.

Forney, J. L. 1968. Production of young northern pike in a regulated marsh. N.Y. Fish Game J. 15(2):143-154.

Forney, J. L. 1971. Development of dominant year classes in a yellow perch population. Trans. Am. Fish. Soc. 100(4):739-749.

Forney, J. L. 1977. Evidence of inter- and intraspecific competition as factors regulating walleye (Stizostedion vitreum vitreum) biomass in Oneida Lake. J. Fish. Res. Board Can. 34(10):1812-1820.

Foster, F. J. 1919. White perch notes and method of propagation. Trans. Am. Fish. Soc. 48(3):160-165.

Foster, N. R. 1967. Comparative studies on the biology of killifishes (Pisces: Cyprinodontidae). Ph.D. Thesis, Cornell Univ.

Fowler, H. W. 1909. A synopsis of the Cyprinidae of Pennsylvania. Proc. Acad. Nat. Sci. Philadelphia, Vol. 60(3):517-553.

Fowler, H. W. 1917. Some notes on the breeding habits of local catfishes. Copeia 42:32-36.

Fowler, H. W. 1921. Spawning habits of pike, killifishes, etc. The Fish Cult. 1(4):36-37.

Fowler, H. W. 1922. Spawning habits of pike, killifishes, etc. The Fish Cult. 2(3):141-142.

Fowler, H. W. 1923. Spawning habits of sunfishes, basses, etc. The Fish Cult. 2(13):226-228.

Fowler, H. W. 1925. Spawning habits of sunfishes, basses, etc. The Fish Cult. 4(7):363-364.

Fowler, H. W. 1932. The fall fish (Semotilus bullaris). The Fish Cult. 12(2):34-35.

Fox, W. S. 1930. The literature of Salmo salar in Lake Ontario and tributary streams. Trans. R. Soc. Can., Sect. 2, Ser. 3, 24:45-55.

Fraleigh, P. C. and K. T. Frank. undated (a). Walleye spawning study. Mimeograph Rep.

Fraleigh, P. C., and K. T. Frank. undated (b). Fish. Mimeograph Rep.

Fraleigh, P. C., and E. J. Tramer. 1975. Fish spawning and migration study. Pages 267-283 in The Maumee Bay Environmental Quality study 1974, final report. Toledo-Lucas County Port Authority/W. W. Knight Foundation/U.S. Army Corps Eng.

Frank, K. T., P. C. Fraleigh, R. D. St. John, and F. L. Reynolds. 1978. A walleye egg deposition appraisal device. Abstracts 21st Conf. Great Lakes Res.:58, Int. Assoc. Great Lakes Res.

Franklin, D. R., and L. L. Smith, Jr. 1963. Early life history of the northern pike, Esox lucius L., with special reference to the factors influencing the numerical strength of year classes. Trans. Am. Fish. Soc. 92(2):91-110.

Fraser, J. M. 1955. The smallmouth bass fishery of South Bay, Lake Huron. J. Fish. Res. Board Can. 12(1):147-177.

Freedman, P. L. 1974. Saginaw Bay: an evaluation of existing and historical conditions. EPA-905/9-74-003, U.S. Environ. Prot. Agency, Reg. V, Enforcement Div., Great Lakes Initiative Contract Program.

Frey, D. G. 1940. Growth and ecology of the carp, Cyprinus carpio Linnaeus, in four lakes of the Madison region, Wisconsin. Ph.D. Thesis, Univ. Wis.-Madison.

Frisby, R. 1942. The food habits of "gars." Ohio Conserv. Bull. 6(2):12-13.

Fry, F. E. J. 1937. The summer migration of the cisco, Leucichthys artedi (LeSueur), in Lake Nipissing, Ontario. Univ. Toronto Stud., Biol. Ser., No. 44, Publ. Ont. Fish. Res. Lab. No. 55.

Fry, F. E. J. 1953. The 1944 year class of lake trout in South Bay, Lake Huron. Trans. Am. Fish. Soc. 82:178-192.

Fuchs, E. H. 1967. Life history of the emerald shiner, Notropis atherinoides, in Lewis and Clark Lake, South Dakota. Trans. Am. Fish. Soc. 96(3):247-255.

Fuiman, L. A. 1979. Descriptions and comparisons of catostomid fish larvae: Northern Atlantic drainage species. Trans. Am. Fish. Soc. 108(6):560-603.

Fuiman, L. A., and D. C. Witman. 1979. Descriptions and comparisons of catostomid fish larvae: Catostomus catostomus and Moxostoma erythrurum. Trans. Am. Fish. Soc. 108(6):604-619.

Gage, S. H. 1893. The lake and brook lampreys of New York, especially those of Cayuga and Seneca Lakes. Wilder Quarter-Century Book:421-493.

Gage, S. H. 1928. The lampreys of New York state--life history and economics. Pages 158-191 in A biological survey of the Oswego River system. Suppl. to 17th Annu. Rep. (1927), N. Y. Conserv. Dep., Albany.

Galbraith, M. G., Jr. 1976. Atlantic salmon in the Great Lakes (Michigan waters). Mich. Dep. Nat. Resour. Perf. Rep., Dingell-Johnson Proj. No. F-35-R-2, Study No. 10, July 1, 1975-June 30, 1976.

Galbraith, M. G., Jr. 1977. Atlantic salmon in the Great Lakes (Michigan waters). Mich. Dep. Nat. Resour. Perf. Rep., Dingell-Johnson Proj. No. F-35-R-3, Study No. 10, July 1, 1976-Sept. 30, 1977.

Galbraith, M. G., Jr. 1978. Atlantic salmon in the Great Lakes (Michigan waters). Mich. Dep. Nat. Resour. Perf. Rep., Dingell-Johnson Proj. No. F-35-R-4, Study No. 410, Oct. 1977-Sept. 30, 1978.

Gale, W. F., and H. W. Mohr. 1976. Fish spawning in a large Pennsylvania river receiving mine effluents. Proc. Penn. Acad. Sci. 50:160-162.

Galloway, J. E., and N. R. Kevern. 1976. Michigan suckers, their life histories, abundance and potential for harvest. Mich. Sea Grant Prog. Tech. Rep. No. 53 (MICHU-SG-206).

Gammon, J. R. 1976. Measurement of entrainment and predictions of impact on the Wabash and Ohio Rivers. Pages 159-176 in 3rd Natl. Workshop on Entrainment and Impingement, Section 316(b)-Research and Compliance, Loren D. Jensen, ed.

Garland, C. 1973. Summary of muskie egg collection at Rocky Fork Lake, 1965-1973. Wildlife In-Service Note No. 220. Ohio Dep. Nat. Resour., Div. Wildl.

Garmaker, J. J. 1977. Erie Mining Company, Taconite Harbor Power Plant, final report, biological monitoring program, cooling water intake, Jan.-Dec. 1976.

Garman, H. 1889. A preliminary report on the animals of the waters of the Mississippi Bottoms, near Quincy, Ill., in August, 1888. Rep. Ill. State Fish Comm. (1888).

Garrett, L. 1949. Copeland's darter (Cottogaster copelandi Jordan). Manuscript rep., Stone Inst. Hydrobiol.

Gasaway, C. 1969. Walleye. Pages 62-63 in Progress in sport fishery research 1968. U.S. Fish Wildl. Serv. Resour. Publ. 77.

Gasaway, C. R. 1970. Changes in the fish population in Lake Francis Case in South Dakota in the first 16 years of impoundment. U.S. Fish Wildl. Serv. Tech. Pap. No. 56.

Geare, R. L. 1884. The lake whitefish--Coregonus clupeaformis. Pages 507-540 in The Fisheries and Fishery Industries of the United States, sect. I, part III, G. B. Goode, ed., U.S. Comm. Fish Fish., Wash., D.C.

Geen, G. H., T. G. Northcote, G. E. Hartman, and C. C. Lindsey. 1966. Life history of two species of catostomid fishes in Sixteenmile Lake, British Columbia, with particular reference to inlet spawning. J. Fish. Res. Board Can. 23(11):1761-1788.

Gehres, R. E., and R. L. Scholl. 1969. Walleye sampling. Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-8, Job No. 2.

Geis, J. W., and N. P. Hyduke. 1978. Habitat mapping and critical habitat studies. Tech. Rep. N in Environmental assessment, FY 1979 winter navigation demonstration on the St. Lawrence River, Tech. Rep., Vol. II.

GPU (General Public Utilities) Service Corporation. 1979. Environmental report for Coho Generating Station Unit 1 (for Penn. Electric Co., Jersey Central Power and Light Co. and Metropolitan Edison Co.).

Geo-Marine Inc. 1978. 316(b) demonstration for the Edgewater Generating Station. Prep. for Ohio Edison Co., August 18, 1978.

George, E. L. 1978. The comparative ecology of young-of-the-year rock bass (Ambloplites rupestris) and smallmouth bass (Micropterus dolomieui) of the upper Niagara River. M.S. Thesis, State Univ. N.Y.-Buffalo.

George, E. L., and W. F. Hadley. 1979. Food and habitat partitioning between rock bass (Ambloplites rupestris) and smallmouth bass (Micropterus dolomieui) young-of-the-year. Trans. Am. Fish. Soc. 108(3):253-261.

Gerking, S. 1953. Evidence for the concepts of home range and territory in stream fishes. Ecology 34(2):347-365.

Gilbert, C. R. 1953. Age and growth of the yellow stone catfish, Noturus flavus (Rafinesque). M.S. Thesis, Ohio State Univ.

Gill, T. 1904. A remarkable genus of fishes--the Umbras. Smithson. Misc. Collect. 45:295-305.

Gill, T. 1907. Parental care among fresh-water fishes. Rep. Smithson. Inst. for 1905, 403-531.

Gill, T. 1908. Life history of the common eel. Trans. Am. Fish. Soc. 37:115-121.

Gleason, G. R., and D. J. Behmer. 1975. Navigation and winter recreation. Lake Superior State College for U.S. Bur. Outdoor Recreation.

Gleason, G. R., D. J. Behmer, and R. Hook. undated. Evaluation of lake whitefish and herring spawning grounds as they may be affected by excessive sedimentation induced by vessel entrapment due to the ice environment within the St. Marys River system. Environmental Evaluation Work Group FY 1979 studies of the Winter Navigation Demonstration Program. Lake Superior State College.

Gollat, R. 1976. The fish and wildlife values of the Black Bay Peninsula and offshore Lake Superior islands (a preliminary investigation). Ont. Min. Nat. Resour., unpubl.

Goode, G. B. 1881. The eel question. Trans. Am. Fish. Soc. 10:81-123.

Goode, G. B. 1884. The food fishes of the United States. Pages 163-682 in The Fisheries and Fishery Industries of the United States, G.B. Goode, ed. U.S. Comm. Fish Fish., Wash., D.C.

Gordon, W. C. 1957. Biology of the American smelt, Osmerus mordax (Mitchell) of Saginaw Bay, Lake Huron. M.S. Thesis, Univ. Mich.

Gordon, W. G. 1961. Food of the American smelt in Saginaw Bay, Lake Huron. Trans. Am. Fish. Soc. 90(4):439-443.

Gordon, W. G. 1968. The bait minnow industry of the Great Lakes. U.S. Fish Wildl. Serv. Fish. Leaf. 608.

Graham, J. J. 1956. Observations on the alewife, Pomolobus pseudoharengus (Wilson), in fresh water. Univ. Toronto Biol. Series No. 62, Publ. Ont. Fish. Res. Lab., No. 74.

Gray, J. W. 1942. Studies of Notropis atherinoides Rafinesque in the Bass Islands region of Lake Erie. M.S. Thesis, Ohio State Univ.

Great Lakes Basin Commission. 1975. Great Lakes Basin Framework Study, Append. 8, Fish.

Great Lakes Fishery Commission. 1957. Annual report for the year 1957. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1958. Annual report for the year 1958. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1959. Annual report for the year 1959. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1960. Annual report for the year 1960. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1961. Annual report for the year 1961. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1962. Annual report for the year 1962. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1964. Annual report for the year 1963. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1967. Annual report for the year 1966. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1968a. Annual report for the year 1967. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1968b. Minutes of the Lake Superior Committee (Annual Meeting). LSC Doc. 68-1.

Great Lakes Fishery Commission. 1969. Annual report for the year 1968. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1970a. Annual report for the year 1969. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1970b. Lake Michigan Committee 1970 annual meeting, minutes.

Great Lakes Fishery Commission. 1972. Annual report for the year 1970. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1973a. Annual report for the year 1971. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1973b. Annual report for the year 1972. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1975. Annual report for the year 1973. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1976a. Annual report for the year 1974. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1976b. Lake Michigan Committee, minutes with appendices.

Great Lakes Fishery Commission. 1976c. Wisconsin--Status of fish stocks. Pages 38-50, Append. VI in Lake Michigan comm., minutes with append.

Great Lakes Fishery Commission. 1977a. Lake Erie Committee, 1977 annual meeting, minutes.

Great Lakes Fishery Commission. 1977b. Minutes (with appendices)--Lake Michigan Committee 1977 annual meeting. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1978. Annual report for the year 1975. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1979a. Annual report for the year 1976. Ann Arbor, Mich.

Great Lakes Fishery Commission. 1979b. Rehabilitating Great Lakes ecosystems. Great Lakes Fish. Comm. Tech. Rep. No. 37.

Great Lakes Fishery Commission. In press. Summary of trout, splake and salmon plantings in the Great Lakes. Append. B, 1978 Annu. Rep. Ann Arbor, Mich.

Great Lakes Fishery Laboratory. 1970. Physical and ecological effects of waste heat on Lake Michigan. U.S. Bur. Commer. Fish., Ann Arbor, Mich.

Greeley, J. R. undated. Conservation of the black bass resource of the Lake Ontario-St. Lawrence region. N.Y. Conserv. Dep. Leaf.

Greeley, J. R. 1927. Fishes of the Genesee region with annotated list. Pages 47-66 *in* A biological survey of the Genesee River system. Suppl. to 16th Annu. Rep. (1926), N.Y. Conserv. Dep.

Greeley, J. R. 1928. Fishes of the Oswego watershed. Pages 84-107 *in* A biological survey of the Oswego River System, Suppl. to 17th Annu. Rep. (1927), N.Y. Conserv. Dep.

Greeley, J. R. 1929. Fishes of the Erie-Niagara watershed. Pages 150-180 *in* A biological survey of the Erie-Niagara System. Suppl. 18th Annu. Rep. (1928), N.Y. Conserv. Dep.

Greeley, J. R. 1932. The spawning habits of brook, brown and rainbow trout, and the problem of egg predators. Trans. Am. Fish. Soc. 62:239-248.

Greeley, J. R. 1933. The growth rate of rainbow trout from some Michigan waters. Trans. Am. Fish. Soc. 63:361-378.

Greeley, J. R. 1934. Fishes of the Raquette watershed with annotated list. Pages 53-108 *in* A biological survey of the Raquette watershed. Suppl. to 23rd Annu. Rep. (1933), N.Y. Conserv. Dep.

Greeley, J. R. 1935. Fishes of the watershed with annotated list. Pages 63-101 *in* A biological survey of the Mohawk-Hudson watershed. Suppl. 24th Annu. Rep. (1934), N. Y. Conserv. Dep.

Greeley, J. R. 1940. Fishes of the watershed with annotated list. Pages 42-81 *in* A biological survey of the Lake Ontario watershed. Suppl. 29th Annu. Rep. (1939), N.Y. Conserv. Dep.

Greeley, J. R. 1955. White bass. N.Y. State Conserv. 10(1):29.

Greeley, J. R. and S. C. Bishop. 1932. Fishes of the area with annotated list. Pages 54-93 *in* A biological survey of the Oswegatchie and Black River systems (including also the lesser tributary streams of the upper St. Lawrence and of northeastern Lake Ontario). Suppl. 21st Annu. Rep. (1931), N.Y. Conserv. Dep.

Greeley, J. R., and C. W. Greene. 1931. Fishes of the area with annotated list. Pages 44-94 in A biological survey of the St. Lawrence watershed (including the Grass, St. Regis, Salmon, Chateaugay systems and the St. Lawrence between Ogdensburg and the International Boundary). Suppl. 20th Annu. Rep. (1930), N.Y. Conserv. Dep.

Green, C. K. 1908. The increase of whitefish and lake trout in Lake Ontario. Trans. Am. Fish. Soc. 37:82-84.

Green, S. 1880. The alewife in fresh water. For. Stream 15(9):167.

Greenbank, J., and P. R. Nelson. 1959. Life history of the threespine stickleback Gasterosteus aculeatus Linnaeus in Karluk Lake and Bare Lake Kodiak Island, Alaska. U.S. Fish Wildl. Serv. Fish. Bull. 59(153):537-559.

Greene, C. W. 1930. The smelts of Lake Champlain. Pages 105-129 in A biological survey of Champlain watershed. Suppl. 19th Annu. Rep. (1929), N.Y. Conserv. Dep.

Greene, C. W. 1940. Stocking policy for the Ontario watershed with suggestions for other fish management methods. Pages 20-41 in A biological survey of the Lake Ontario watershed. Suppl. 29th Annu. Rep. (1939), N.Y. Conserv. Dep.

Greene, C. W. 1955. Lake trout. N.Y. State Conserv. 9(5):26-28.

Greene, C. W., R. P. Hunter, and W. C. Senning. 1932. Stocking policy for streams, lakes, and ponds in the Oswegatchie and Black River systems (including also the lesser tributary streams of the upper St. Lawrence and of northeastern Lake Ontario). Pages 18-53 in A biological survey of the Oswegatchie and Black River systems (including also the lesser tributary streams of the upper St. Lawrence and of northeastern Lake Ontario). Suppl. 21st Annu. Rep. (1931), N.Y. Conserv. Dep.

Griffin, S. 1980. Rifle sucker runs make that river a "booming fishery." The Ann Arbor News, April 13, 1980.

Griffiths, J. S. 1976a. Effects of constant and fluctuating temperatures on the developmental rate and hatching success of yellow perch eggs. Ont. Hydro Res. Div. Rep. No. 76-499-K.

Griffiths, J. S. 1976b. Effects of once-through cooling on fish spawning and early life--baseline study at Lennox GS and Bruce Nuclear Power Development. Ont. Hydro Res. Div. Rep. 76-335-K.

Griffiths, J. S. 1978a. Potential effects of unstable thermal discharge plumes on Great Lakes rainbow smelt eggs. Ont. Hydro Res. Div. Rep. No. 78-343-K.

Griffiths, J. S. 1978b. Fish growth at Great Lakes generating station sites. Ont. Hydro Res. Div. Rep. No. 78-52-K.

Griffiths, J. S. 1978c. Potential effects of unstable thermal discharge plumes on yellow perch eggs. Ont. Hydro Res. Div. Rep. No. 78-586-K.

Griswold, B. L. 1970. The ecology of the ninespine stickleback, Pungitius pungitius (Linnaeus), in western Lake Superior. Ph.D. Thesis, Univ. Minn.

Griswold, B. L., C. Edwards, L. Woods, and E. Weber. 1978. Some effects of stream channelization on fish populations, macroinvertebrates, and fishing in Ohio and Indiana. FWS/OBS 77/46. Ohio Coop. Fish. Res. Unit, Columbus.

Griswold, B. L., and L. L. Smith, Jr. 1972. Early survival and growth of the ninespine stickleback, Pungitius pungitius. Trans. Am. Fish. Soc. 101(2):350-352.

Griswold, B. L., and L. L. Smith. 1973. The life history and trophic relationship of the ninespine stickleback, Pungitius pungitius, in the Apostle Islands area of Lake Superior. U.S. Natl. Mar. Fish. Serv. Fish. Bull. 71(4):1039-1960.

Grosse Ile Laboratory. 1972. Lake Michigan entrainment studies, Big Rock Nuclear Power Plant, Escanaba Power Plant, November-December 1971. Grosse Ile Laboratory Working Rep. No. 1, U.S. Environ. Prot. Agency, Grosse Ile, MI.

Guard, T. T. 1953. The sea lamprey in inland waters. Mich. Conserv. 22(3):14-15, 19-20.

Guidice, J. J. 1965. Investigations on the propagation and survival of flathead catfish in troughs. Proc. S. E. Assoc. Game Fish. Comm. 17:178-180.

Gunckel, J. E. 1892. Fish and fishing in Ohio. Trans. Am. Fish. Soc. 21(2):15-21.

Gunderson, J. L. 1978. Vital statistics of the lake whitefish in three areas of Green Bay, Lake Michigan with comparison to Lake Michigan east of Door County, Wisconsin. M.S. Thesis, Univ. Wis.-Stevens Point.

Haas, R. C. 1973. Status of fish stocks on Michigan waters of Lake Erie and Lake St. Clair--1972. Mich. Dep. Nat. Resour.

Haas, R. C. 1978. The muskellunge in Lake St. Clair. Pages 334-339 in A Symposium on Selected Coolwater Fishes of North America, R. L. Kendall, ed., Am. Fish. Soc. Spec. Publ. 11.

Haas, R. C., and W. C. Bryant. Undated. Status of the fisheries resource in Lake St. Clair and connecting waters. Mich. Dep. Nat. Resour., Mt. Clemens.

Hacker, V. A. 1957. Biology and management of lake trout in Green Lake, Wisconsin. Trans. Am. Fish. Soc. 86:71-83.

Hacker, V. A. 1962. A summarization of life history information of the lake trout, *Salvelinus namaycush*, obtained in gill netting, finclipping and tagging studies at Green Lake, Wisconsin--1956-1961. Wis. Conserv. Dep., East Central Area, Invest. Memo. No. 3.

Hackney, P. A., G. R. Hooper, and J. F. Webb. 1971. Spawning behavior, age and growth, and sport fishery for the silver redhorse, *Moxostoma anisurum* (Rafinesque), in the Flint River, Alabama. Proc. Southeast Assoc. Game Fish Comm. 24:569-576.

Hagen, D. W. 1967. Isolating mechanisms in threespine sticklebacks (*Gasterosteus*). J. Fish. Res. Board Can. 24(8):1637-1692.

Haines, T. A., J. C. Makarewicz, and R. H. Ellis. 1977. Spring movement and spawning activity of fish in the vicinity of the proposed dredging operations, Irondequoit Bay, New York. Rep. prep. for U.S. Army Corps of Eng., Buffalo Dist.

Hair, D. E. 1978. Lake Erie smallmouth bass survey. Ohio Dep. Nat. Resour. Wildl., In-Serv. Note 392 (Sept. 1978).

Hair, D. E. 1979. Some aspects of the life history of the smallmouth bass (*Micropterus dolomieui dolomieui*) in the Bass Islands area of Lake Erie. M.S. Thesis, Ohio State Univ.

Hair, D. E., and R. L. Scholl. 1971. Walleye Sampling. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-10, Job No. 2, July 1, 1971-June 30, 1972.

Hale, J. 1960. Some aspects of the life history of the smelt (*Osmerus mordax*) in western Lake Superior. Minn. Fish Game Invest., Ser. 2:25-41.

Hale, J. G., and D. A. Hilden. 1969. Spawning and some aspects of early life history of brook trout, *Salvelinus fontinalis* (Mitchill), in the laboratory. Trans. Am. Fish. Soc. 98(3):473-477.

Hall, D. J., and E. E. Warner. 1977. Seasonal distribution and abundance of fishes in the littoral zone of a Michigan lake. Trans. Am. Fish. Soc. 106(6):545-555.

Hamley, J. M. 1979. Fish. Nanticoke Environmental Committee, Abstracts of seminar presentations.

Hamley, J. M., and N. G. MacLean. 1979. Impacts of Nanticoke industrial development. Contact 11(1):81-115.

Hamilton, J. G., and P. M. Powles. 1979. Feeding habits and growth of young-of-the-year largemouth bass (*Micropterus salmoides*) near its northern limit, Nogies Creek. Ont. Can. J. Zool. 57(7):1431-37.

Hankinson, T. L. 1908. A biological survey of Walnut Lake, Michigan. Rep. Biol. Surv. State Mich., Rep. State Board Geol. Surv. (1907):154-271.

Hankinson, T. L. 1913. Distribution of fish in the streams about Charleston, Illinois. Trans. Ill. Acad. Sci. 6:102-113.

Hankinson, T. L. 1914. Young whitefish in Lake Superior. Science, N.S. 40(1024):239-240.

Hankinson, T. L. 1916. Results of the Shiras expedition to Whitefish Point, Michigan: Fishes. Mich. Geol. Biol. Surv. Publ. 20(Biol. Ser. 4):109-179.

Hankinson, T. L. 1919. Notes on life-histories of Illinois fish. Trans. Ill. State Acad. Sci. 12:132-150.

Hankinson, T. L. 1920. Report on investigations of the fish of the Galien River, Berrien County, Mich. Occas. Pap., Mus. Zool., Univ. Mich. No. 89:1-14.

Hankinson, T. L. 1930. Breeding behavior of the silverfin minnow, *Notropis whipplei spilopterus* (Cope). Copeia 1930(3):73-74.

Hankinson, T. L. 1932. Observations on the breeding behavior and habits of fishes in southern Michigan. Pap. Mich. Acad. Sci. Arts Lett. 15:411-425.

Hann, H. W. 1927. The history of the germ cells of *Cottus bairdii* Girard. J. Morph. Physiol. 43(2):427-297.

Hannuksela, P. R. 1973. Food interrelationships of the mottled sculpin, *Cottus bairdi* and juveniles of the rainbow trout, *Salmo gairdneri*, in a tributary of Lake Superior. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1801.

Hannuksela, P. R., and T. M. Stauffer. 1975. Coho salmon in Michigan tributaries of Lake Superior, 1966-1974. Mich. Dep. Nat. Resour. Tech. Rep. No. 75-7.

Hansen, D. F. 1943. On nesting of the white crappie, *Pomoxis annularis*. Copeia 1943(4):259-260.

Hansen, D. F. 1951. Biology of the white crappie in Illinois. Ill. Nat. Hist. Surv. Bull. 25(4):211-265.

Hansen, D. F. 1965. Further observations on nesting of white crappie, *Pomoxis annularis*. Trans. Am. Fish. Soc. 94(2):182-184.

Hansen, E. A. 1975. Some effects of groundwater on brown trout redds. Trans. Am. Fish. Soc. 104(1):100-110.

Hansen, M. J., and D. W. Hayne. 1962. Sea lamprey larvae in Ogontz Bay and Ogontz River, Michigan. J. Wildl. Manage. 26(3):237-247.

Hansen, M. J., and T. M. Stauffer. Comparative recovery to the creel, and behavior of rainbow trout stocked in the Great Lakes. Mich. Dep. Conserv., Res. Dev. Rep. No. 113.

Hansen, M. J., and T. M. Stauffer. 1971. Comparative recovery to the creel, movement and growth of rainbow trout stocked in the Great Lakes. Trans. Am. Fish. Soc. 100(2):336-349.

Hanson, L. H., and P. J. Manion. 1978. Chemosterilization of the sea lamprey (Petromyzon marinus). Great Lakes Fish. Comm. Tech. Rep. No. 29.

Hardin, B. L. 1894. Notes: Lake Erie investigation. Joint Fish. Comm.

Harkness, W. J. K. 1923. The rate of growth and the food of the lake sturgeon (Acipenser rubicundus LeSueur). Univ. Toronto Stud. Biol. Ser. No. 24, Publ. Ont. Fish. Res. Lab No. 18:18-42.

Harkness, W. J. K., and J. R. Dymond. 1961. The lake sturgeon, the history of its fishery and problems of conservation. Ont. Dep. Lands For.

Harkness, W. J. K., and W. E. Ricker. 1929. A preliminary study of some trout waters of Ontario. Trans. Am. Fish. Soc. 59:256-267.

Harrington, R. W., Jr. 1947a. The breeding behavior of the bridled shiner, Notropis bifrenatus. Copeia 1947(3):186-192.

Harrington, R. W., Jr. 1947b. The early life history of the bridled shiner, Notropis bifrenatus (Cope). Copeia 1947(2):97-100.

Harris, L. A., C. W. Bond, and H. C. Post. 1882. Report of commissioners. 6th Annu. Rep. Ohio Fish. Comm. (1881):1427-1432.

Harris, V. T., and P. H. Eschmeyer (ed.). 1975. Sport fishery and wildlife research 1973-74. U.S. Fish Wildl. Serv.

Harrison, E. J. 1978. Comparative ecologic life histories of sympatric populations of Esox lucius and Esox masquinongy of the upper Niagara River and its local watershed. Ph.D. Thesis, State Univ. N.Y.-Buffalo.

Harrison, E. J., and W. F. Hadley. 1978. Ecologic separation of sympatric muskellunge and northern pike. Pages 129-134 in A Symposium on Selected Coolwater Fishes of North America, R. L. Kendall, ed. Am. Fish. Soc. Spec. Publ. 11.

Harrison, E. J., and W. F. Hadley. 1979. Biology of muskellunge (Esox masquinongy) in the upper Niagara River. Trans. Am. Fish. Soc. 108(5):444-451.

Harry, G. Y., Jr. 1969. Salmon, Pacific. Pages 588-594 in Encyclopedia of marine resources, Frank E. Firth, ed. Van Nostrand Reinhold Co., New York.

Hart, J. L. 1926. The rate of growth of the common whitefish Coregonus clupeaformis (Mitchill). M.S. Thesis, Univ. Toronto.

Hart, J. L. 1929. The capture of young whitefish in the Bay of Quinte. Science, N.S. 70(1812):284.

Hart, J. L. 1930. The spawning and early life history of the whitefish, Coregonus clupeaformis (Mitchill), in the Bay of Quinte, Ontario. Contrib. Can. Biol. Fish., N.S. 6(7):165-214.

Hartley, R. P., C. E. Herdendorf, and M. Keller. 1966. Synoptic water sampling survey in the western basin of Lake Erie. Univ. Mich., Great Lakes Res. Div. Publ. 15:301-322.

Hartley, S. M. 1975. Limnological analysis of Sandusky Bay, Lake Erie, Ohio. M.S. Thesis, Ohio State Univ.

Hartley, S., and C. E. Herdendorf. 1975. Abundance and population trends of Sandusky Bay fishes. Pages 380-422 in Proc. Sandusky River Basin Symp., May 2-3, 1975.

Hartman, G. F. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon (Oncorhynchus kisutch) and steelhead trout (Salmo gairdneri). J. Fish. Res. Board Can. 22(4):1035-1081.

Hartman, W. L. 1957. Finger Lakes rainbows--a chronicle of their progress from egg to adult. N.Y. State Conserv. 11(6):20-22, 34.

Hartman, W. L. 1959. Biology and vital statistics of rainbow trout in the Finger Lakes region, New York. N.Y. Fish Game J. 6(2):121-178.

Hartman, W. L. 1972. Lake Erie: Effects of exploitation, environmental changes and new species on the fishery resources. J. Fish. Res. Board Can. 29(6):899-912.

Hasler, A. D., R. M. Horrall, W. J. Wisby, and W. Braemer. 1958. Sun-orientation and homing in fishes. Limnol. Oceanogr. 3(4):353-361.

Hasler, A. D., A. T. Scholz, and R. M. Horrall. 1978. Olfactory imprinting and homing in salmon. Am. Sci. 66:347-355.

Hassinger, R. 1970. Operation of fish trap in French River for coho salmon. Minn. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-26-R-1, Job No. IV-2, July 1, 1969-March 31, 1970.

Hassinger, R. 1971a. Operation of fish trap in French River for coho salmon. Minn. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-26-R-2, Job No. IV-2, April 1, 1970-March 30, 1971.

Hassinger, R. 1971b. Coho reproduction in north shore streams. Minn. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-26-R-2, Job No. IV-6, April 1, 1970-March 31, 1971.

Hassinger, R. 1974. Evaluation of coho salmon (Oncorhynchus kisutch) as a sport fish in Minnesota. Minn. Dep. Nat. Resour. Invest. Rep. 328.

Hassinger, R. L., J. G. Hale, and D. E. Woods. 1974. Steelhead of the Minnesota North Shore. Minn. Dep. Nat. Resour. Tech. Bull. No. 11.

Hatch, J. T., and B. F. Clark. 1977. Morone chrysops (Rafinesque): the white bass in Lake Superior. J. Minn. Acad. Sci. 43:7.

Hatch, R. W. 1957a. Finger Lakes rainbows--spawning habits. N.Y. State Conserv. 11(4):20-22.

Hatch, R. W. 1957b. Success of natural spawning of rainbow trout in the Finger Lakes region of New York. N.Y. Fish Game J. 4(1):69-87.

Havey, K. A., and K. Warner. 1970. The landlocked salmon (Salmo salar), its life history and management in Maine. Sport Fish. Inst. and Maine Dep. Inland Fish. Game.

Hawley, M. G. 1967. A study of the northern redhorse (Moxostoma macrolepidotum) in the Plover River and Peshtigo River, Wisconsin. Univ. Wis.-Stevens Point.

Hay, O. P. 1894. The lampreys and fishes of Indiana. Annu. Rep. Ind. Dep. Geol. Nat. Resour. 19:147-296.

Hayes, M. L. 1957. Life history studies of two species of suckers in Shadow Mountain Reservoir, Grand County, Colorado. Colo. Coop. Fish. Res. Unit. Rep. 3:2-10.

Haynes, J. M., J. C. Makarewicz, and R. Dilcher. 1979. Aquatic biological survey, Cape Vincent Harbor, New York. Final rep. to the U.S. Army Corps of Eng., Buffalo Dist.

Hazzard, A. S. 1931. Stocking policy for the streams, lakes and ponds of the St. Lawrence watershed including the Grass, St. Regis, Salmon, Chateaugay systems and the St. Lawrence between Ogdensburg and the International boundary. Pages 14-43 in A biological survey of the St. Lawrence watershed (including the Grass, St. Regis, Salmon, Chateaugay systems and the St. Lawrence between Ogdensburg and the International Boundary). Suppl. 20th Annu. Rep. (1930), N. Y. Conserv. Dep.

Hazzard, A. S. 1932. Some phases of the life history of the eastern brook trout, Salvelinus fontinalis Mitchell. Trans. Am. Fish. Soc. 62:344-350.

Hazzard, A. S. 1951. The walleye--fish of mystery. Mich. Conserv. 20(4):7.

Heard, W. R., and W. L. Hartman. 1966. Pygmy whitefish, Prosopium coulteri, in the Naknek River system of southwest Alaska. U.S. Fish Wildl. Serv. Fish. Bull. 65(3):555-579.

Hedges, S. B., and R. C. Ball. 1953. Production and harvest of bait fishes in Michigan. Mich. Dep. Conserv., Inst. Fish Res., Misc. Publ. No. 6.

Heniken, M. R. 1977. Distribution and abundance of larval fish in western Lake Erie. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 69.

Herdendorf, C. E. 1977. Assessment of the larval fish populations in Maumee River Estuary and Maumee Bay of Lake Erie. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 75.

Herdendorf, C. E., and L. C. Cooper. 1975. Environmental impact assessment of commercial sand and gravel dredging in Maumee River and Maumee Bay. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 41.

Herdendorf, C. E., and L. C. Cooper. 1976. Investigations of larval fish populations in Maumee River Estuary and Bay and assessment of the impact of commercial sand and gravel dredging on these populations. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 49.

Herdendorf, C. E., C. L. Cooper, M. R. Heniken, and F. L. Snyder. 1976. Western Lake Erie fish larvae study, 1975 preliminary data report. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 47.

Herman, E. F. 1947. Notes on tagging walleyes on the Wolf River. Wis. Conserv. Bull. 12(4):7-9.

Herman, E., W. Wishy, L. Wiegert, and M. Burdick. 1959. The yellow perch--its life history, ecology, and management. Wis. Conserv. Dep. Publ. 228:1-14.

Hess, R., P. Vidal, and B. Muench. 1979. The 1977 and 1978 fall index fish population surveys of the Illinois waters of Lake Michigan. Ill. Dep. Conserv. unpubl. rep.

Hildebrand, S. G. 1971. The effect of coho spawning on the benthic invertebrates of the Platte River, Benzie County, Michigan. Trans. Am. Fish. Soc. 100(1):61-68.

Hile, R. 1936. Age and growth of the cisco, Leucichthys artedi (Le Sueur), in the lakes of northeastern highlands, Wisconsin. U.S. Fish Wildl. Serv. Fish. Bull. 48(19):211-317.

Hile, R. 1937. The increase in abundance of the yellow pike-perch, Stizostedion vitreum (Mitchill), in Lakes Huron and Michigan in relation to the artificial propagation of species. Trans. Am. Fish. Soc. 66(1936):143-159.

Hile, R. 1941. Age and growth of the rock bass, Ambloplites rupestris (Rafinesque) in Nebish Lake, Wisconsin. Trans. Wis. Acad. Sci. Arts, Lett. 33:189-337.

Hile, R. 1953. Perch studies in Green Bay. Prog. Fish Cult. 15(3):133-134.

Hile, R. 1954. Fluctuations in growth and year-class strength of the walleye in Saginaw Bay. U.S. Fish Wildl. Serv. Fish Bull. 56(91):1-58.

Hile, R., and H. J. Buettner. 1959. Fluctuations in the commercial fisheries of Saginaw Bay, 1885-1956. U.S. Fish Wildl. Serv. Res. Rep. 51.

Hile, R., and H. J. Deason. 1934. Growth of the whitefish, *Coregonus clupeaformis* (Mitchill), in Trout Lake, northeastern highlands, Wisconsin. Trans. Am. Fish. Soc. 64:231-237.

Hile, R., and H. J. Deason. 1947. Distribution, abundance and spawning season and grounds of the kiyi, *Leucichthys kiyi* Koelz in Lake Michigan. Trans. Am. Fish. Soc. 74:144-165.

Hile, R., and F. W. Jobes. 1941. Age, growth and production of the yellow perch, *Perca flavescens* (Mitchill), of Saginaw Bay. Trans. Am. Fish. Soc. 70:102-122.

Hile, R., and F. W. Jobes. 1942. Age and growth of the yellow perch, *Perca flavescens* (Mitchill), in the Wisconsin waters of Green Bay and northern Lake Michigan. Pap. Mich. Acad. Sci. Arts Lett. 27:24-266.

Hile, R., G. F. Lunger, and H. J. Buettner. 1953. Fluctuations in the fisheries of State of Michigan waters of Green Bay. U.S. Fish Wildl. Serv. Fish. Bull. 54:1-34.

Hinrichs, M. A., and H. E. Booke. 1975. Egg development and larval feeding of the lake herring, *Coregonus artedii* (Le Sueur). Mus. Nat. Hist., Univ. Wis.-Stevens Point, Rep. on Fauna and Flora of Wis. 14(4):75-86.

Hlauek, R. R., and C. R. Norden. 1978. The reproductive cycle and fecundity of the alewife in Lake Michigan. Wis. Acad. Sci. Arts Lett. 66:80-90.

Hoagman, W. J. 1973. The hatching, distribution, abundance, growth, and food of the larval lake whitefish (*Coregonus clupeaformis* Mitchill) of Central Green Bay, Lake Michigan. Inst. Freshwater Res. (Drottningholm) 53:1-20.

Hodson, R. G. 1973. A comparison of occurrence and abundance of fishes within three Texas reservoirs which receive heated discharges. Ph.D. Thesis, Tex. A & M Univ.

Hogg, D. 1955. The possibility of sea lamprey spawning in Lake Erie. Append. J, Pages 71-73, *in* Annu. Rep. to Great Lakes Res. Comm., 1955, Sect. I.

Hogg, D. M. 1974. Results of Port Severn creel census--spring 1974. Ont. Min. Nat. Resour., unpubl. rep.

Hogman, W. J. 1971. The larvae of the lake whitefish (Coregonus clupeaformis (Mitchill) of Green Bay, Lake Michigan. Ph.D. Thesis, Univ. Wis.

Hohn, M. H. 1966. Analysis of plankton ingested by Stizostedion vitreum vitreum fry and concurrent vertical plankton tows from southwestern Lake Erie, May 1961 and May 1962. Ohio J. Sci. 66(2):193-197.

Holt, C. F. 1888. Some observations on the black bass. Trans. Am. Fish. Soc. 17:33-36.

Hoover, E. E. 1936. Contributions to the life history of the chinook and landlocked salmon in New Hampshire. Copeia 1936(4):193-198.

Hoover, E. E. 1937. Biological survey of the Androscoggin, Saco, and coastal watersheds. N.H. Fish Game Comm.

Horrall, R. M. 1961. A comparative study of two spawning populations of the white bass, Roccus chrysops (Rafinesque), in Lake Mendota, Wisconsin, with special reference to homing behavior. Ph.D. Thesis, Univ. Wis.-Madison.

Horrall, R. M. 1976. Memo to Carlos Fetterolf. Pages 66-76 in Minutes (with append.) of Lake Michigan Comm. Meet., Great Lakes Fish. Comm., Milwaukee, Wis., February 24-25, 1976.

Hosko, M. 1967. Notes of interview conducted by H. A. Regier, June 23.

Hosko, J. 1967. Notes of interview conducted by H. A. Regier, June 24.

Houde, E. D. 1967. Food of pelagic young of the year walleye, Stizostedion vitreum vitreum, in Oneida Lake, New York. Trans. Am. Fish. Soc. 96(1):17-24.

Houde, E. D. 1968. The relation of water currents and zooplankton abundance to distribution of larval walleyes, Stizostedion vitreum vitreum, in Oneida Lake, New York. Ph.D. Thesis, Cornell Univ.

Houde, E. D. 1969a. Distribution of larval walleyes and yellow perch in a bay of Oneida Lake and its relation to water currents and zooplankton. N.Y. Fish Game J. 16(2):184-205.

Houde, E. D. 1969b. Sustained swimming ability of larvae of walleye (Stizostedion vitreum vitreum) and yellow perch (Perca flavescens). J. Fish. Res. Board Can. 26(6):1647-1659.

Houde, E. D., and J. L. Forney. 1970. Effects of water currents on distribution of walleye larvae in Oneida Lake, N.Y. J. Fish. Res. Board Can. 27:445-456.

Hough, E. 1902. Bass spawning in Michigan. For. Stream 58(22):431.

House, R., and L. Wells. 1973. Age, growth, spawning season, and fecundity of the trout-perch (Percopsis omiscomaycus) in southeastern Lake Michigan. J. Fish. Res. Board Can. 30(8):1221-1225.

Howe, H. 1907. Historical collections of Ohio. C. J. Krehbiel and Co., Cincinnati.

Howell, D. Y. 1882. Report of the superintendent of Ohio fish hatcheries. 6th Annu. Rep. Ohio Fish. Comm. (1881):1433-1438.

Hubbard, W. 1977. Studies of fish larvae distribution and abundance near Ashtbula, Ohio. Paper presented at Annu. Ohio Acad. Sci. meeting, Columbus.

Hubbs, C. L. 1919. The nesting habits of certain sunfishes as observed in a park lagoon in Chicago. Aquatic Life 4(11):143-144.

Hubbs, C. L. 1921. An ecological study of the life history of the freshwater atherine fish Labidesthes sicculus. Ecology 2(4):262-276.

Hubbs, C. L. 1923. Seasonal variation in the number of vertebrae of fishes. Pap. Mich. Acad. Sci. Arts Lett. 2:207-214.

Hubbs, C. L. 1929. The fishes. Pages 153-164 in The Book of Huron Mountain. Huron Mountain Club.

Hubbs, C. L. 1930. Fisheries research. Mich. Dep. Conserv. 5th Bienn. Rep. (1929-30).

Hubbs, C. L., and R. M. Bailey. 1938. The small-mouthed bass. Cranbrook Inst. Sci. Bull. No. 10.

Hubbs, C. L., and D. E. S. Brown. 1929. Materials for a distributional study of Ontario fishes. Trans. R. Can. Inst. 17(1):1-56.

Hubbs, C. L., and G. P. Cooper. 1935. Age and growth of the long-eared and green sunfishes in Michigan. Pap. Mich. Acad. Sci. Arts Lett. 20(1934):669-696.

Hubbs, C. L., and G. P. Cooper. 1936. Minnows of Michigan. Cranbrook Inst. Sci. Bull. No. 8.

Hubbs, C. L., and C. W. Creaser. 1924. On the growth of young suckers and the propagation of trout. Ecology 5(4):372-378.

Hubbs, C. L., and R. W. Eschmeyer. 1938. The improvement of lakes for fishing. A method of fish management. Mich. Inst. Fish. Res., Bull. 2:42-48.

Hubbs, C. L., and K. F. Lagler. 1947. Fishes of Isle Royale, Michigan. Pap. Mich. Acad. Sci. Arts Lett. 33:73-133.

Hubbs, C. L., and K. F. Lagler. 1958. Fishes of the Great Lakes region. Cranbrook Inst. Sci. Bull. No. 26.

Hubbs, C. L., and T. E. B. Pope. 1937. The spread of the sea lamprey through the Great Lakes. Trans. Am. Fish. Soc. 66:172-176.

Hubbs, C. L., and K. Strawn. 1963. Differences in the developmental temperature tolerance of central Texas and more northern stocks of *Percina caprodes* (Percidae:Osteichthyes). Southwest Nat. 8(1):43-45.

Humphreys, J. D. 1978. Population dynamics of lake whitefish, *Coregonus clupeaformis*, in Lake Michigan east of Door County, Wisconsin. M.S. Thesis, Univ. Wis.-Stevens Point.

Hunter, J. R. 1963. The reproductive behavior of the green sunfish, *Lepomis cyanellus*. Zoologica 48(1):13-24.

Huntsman, A. G. 1917. The lampreys of eastern Canada. Ottawa Nat. 31(2):23-27.

Huntsman, A. G. 1944. Why did the Lake Ontario salmon disappear? Trans. R. Soc. Can. 38(Ser. 3, Sect. 5):83-102.

Hurley, D. A. 1972a. The American eel (*Anguilla rostrata*) in eastern Lake Ontario. J. Fish. Res. Board Can. 29(5):535-543.

Hurley, D. A. 1972b. Observations on incubating walleye eggs. Prog. Fish Cult. 34(1):49-54.

Hurley, D. A., and W. J. Christie. 1977. Depreciation of the warmwater fish community in the Bay of Quinte, Lake Ontario. J. Fish. Res. Board Can. 34(10):1849-1860.

Imhof, M. A. 1977. Population genetic structure of lake whitefish, (*Coregonus clupeaformis*), in Green Bay and northern Lake Michigan as assessed by electrophoresis of lactate, glycerol-3-phosphate and malate dehydrogenase isoenzymes. M.S. Thesis, Univ. Wis.

Indiana and Michigan Power Company. 1975. Plan of study and demonstration concerning thermal discharges at the Donald C. Cook Nuclear Plant. Donald C. Cook Nuclear Plant, Units 1 and 2, submitted to Mich. Water Resour. Comm.

Indiana and Michigan Power Company. 1977. Report on the impact of cooling water use at the Donald C. Cook Nuclear Plant. Donald C. Cook Nuclear Plant, Units 1 and 2.

Industrial Bio-Test Laboratories, Inc. 1972. Preoperational thermal monitoring program of Lake Michigan near the Kewaunee Nuclear Power Plant, January 1971-December 1971. Rep. to Wis. Public Service Corp., Green Bay, Wis.

Industrial Bio-Test Laboratories, Inc. 1975a. Operational environmental monitoring in Lake Michigan near Zion Station, July 1974 through December 1974. Semi-annu. rep. to Commonwealth Edison Co., Chicago, Vol. II.

Industrial Bio-Test Laboratories, Inc. 1975b. Operational environmental monitoring in Lake Michigan near Zion Station, July 1974 through December 1974. Semi-annu. rep. to Commonwealth Edison Co., Chicago, Vol. I.

Industrial Bio-Test Laboratories, Inc. 1977. Report to Stone and Webster Engineering Corp., Aquatic Sampling Program, Haven Site, Wisconsin Utility Project, Wisconsin Electric Power Company, Final Report, Nov. 1973-Oct. 1974. Append. I in Aquatic sampling program for the Haven Site, Baseline Study: Nov. 1973-Oct. 1974 of Haven Nuclear Plant units 1 and 2. Environ. Rep., construction stage, Vol. 7.

International Great Lakes Levels Board. 1973. Regulation of Great Lakes water levels. Append. D, Fish, Wildlife, Recreation, Rep. to the Int. Joint Comm.

International Lake Superior Board of Control. 1974. Feasibility study of remedial works in the St. Marys Rapids at Sault Ste. Marie. Rep. to the Int. Joint Comm.

Izaak Walton League of America. 1925. Rep. 3rd Annu. Conv. of Wis. Div. (Green Bay):44-45.

Jacobs, D. L. 1948. Nesting of the brook stickleback. Proc. Minn. Acad. Sci. 16:33-34.

Jacoby, C. 1953. Notes on the life history of the deepwater sculpin, Myoxocephalus quadricornis L., in Lake Superior. Ph.D. Thesis, Univ. Mich.

Jaffa, B. B. 1917. Notes on the breeding and incubation periods of the Iowa darter, Etheostoma iowae Jordan and Meek. Copeia 47:71-72.

Jaworski, E., and C. N. Raphael. 1978a. Phase I: Fish, wildlife, and recreational values of Michigan's coastal wetlands. In Coastal wetlands value study in Michigan, Phase I and II, Michigan Coastal Manage. Program.

Jaworski, E., and C. N. Raphael. 1978b. Existing and potential value of wetlands and bottom lands in the Sterling State Park area, Monroe, Michigan. Office of Federal Activities, Region V, U.S. Environ. Prot. Agency, Chicago.

Jenkins, D. H. 1968. Research and Development Division. Mich. Dep. Conserv. Bienn. Rep. 24:199-225.

Jenkins, D. H. 1970. Research and Development Division. Mich. Dep. Nat. Resour. Bienn. Rep. 25:206-230.

Jenkins, D. H. 1972. Research and Development Division. Mich. Dep. Nat. Resour. Bienn. Rep. 26:217-245.

Jenkins, R. E. 1970. Systematic studies of the catostomid fish tribe Moxostomatini. Ph.D. Thesis, Cornell Univ.

Jeppson, P. W. 1960. Evaluation of kokanee and trout spawning areas in Pend Oreille Lake and tributary streams. Idaho Fish Game Dep., Dingell-Johnson Proj. No. F-003-R-10.

Jilek, R., G. Cassell, D. Peale, Y. Garza, L. Riley, and T. Siewart. 1979. Spawning population dynamics of smelt, Osmerus mordax. J. Fish Biol. 15(1):31-35.

Jobes, F. W. 1943. The age, growth, and bathymetric distribution of Reighard's chub, Leucichthys reighardi Koelz, in Lake Michigan. Trans. Am. Fish. Soc. 72:108-135.

Jobes, F. W. 1949a. The age, growth, and distribution of the longjaw cisco, Leucichthys alpenae Koelz, in Lake Michigan. Trans. Am. Fish. Soc. 76:215-247.

Jobes, F. W. 1949b. The age, growth and bathymetric distribution of the bloater, Leucichthys hoyi (Gill), in Lake Michigan. Pap. Mich. Acad. Sci. Arts Lett. 33:135-172.

Jobes, F. W. 1952. Age, growth, and production of yellow perch in Lake Erie. U.S. Fish Wildl. Serv. Fish. Bull. 52:205-266.

Joeris, L. S., and E. G. Karvelis. 1962. The present status of our knowledge of the biology of the alewife in northwestern Lake Michigan and Green Bay. U.S. Bur. Commer. Fish., Ann Arbor, Mich., unpubl. rep.

John, K. R. 1954. An ecological study of the cisco, Leucichthys artedii, in Lake Mendota, Wisconsin. Ph.D. Thesis, Univ. Wis.

John, K. R. 1956. Onset of spawning activities of the shallow water cisco, Leucichthys artedi (LeSueur), in Lake Mendota, Wisconsin, relative to water temperatures. Copeia 1956(2):116-118.

John, K. R., and A. D. Hasler. 1956. Observations on some factors affecting the hatching of eggs and the survival of young shallow-water cisco, Leucichthys artedi LeSueur, in Lake Mendota, Wisconsin. Limnol. Oceanogr. 1(3):176-194.

Johnson, B. G. H. 1951. An investigation of the mooneye (Hiodon tergisus). Abstr. 5th Tech. Sess. Res. Council Ont.

Johnson, C. E. 1971. Factors affecting fish spawning. Wis. Conserv. Bull. 36(4):16-17.

Johnson, D. L., and B. I. Muench. undated. Field sampling program, Project VII, IBT No. W8960, Part C--Fish study, March 1970-October 1970. In Evaluation of thermal effects in southwestern Lake Michigan, Waukegan and Zion Generating Stations, January 1970-April 1971 by Industrial Bio-Test Laboratories, Inc., Vol. II, Chapt. 4.

Johnson, F. H. 1957. Northern pike year-class strength and spring water levels. Trans. Am. Fish. Soc. 86(1956):285-293.

Johnson, F. H. 1961. Walleye egg survival during incubation on several types of bottom in Lake Winnibigoshish, Minnesota, and connecting waters. Trans. Am. Fish. Soc. 90(3):312-322.

Johnson, F. H. 1969. Environmental and species associations of the walleye in Lake Winnibigoshish and connected waters, including observations on food habits and predator-prey relationships. Minn. Fish. Invest. No. 5:5-36.

Johnson, F. H., and J. G. Hale. 1970. Interrelationships between the walleye and smallmouth bass in northeastern Minnesota lakes. Minn. Dep. Conserv. Invest. Rep. 309.

Johnson, F. H., and J. G. Hale. 1977. Interrelations between walleye (*Stizostedion vitreum vitreum*) and smallmouth bass (*Micropterus dolomieu*) in four northeastern Minnesota lakes 1948-1969. J. Fish. Res. Board Can. 34(10):1626-1632.

Johnson, F. H., and M. W. Johnson. 1971. Characteristics of the 1957-1958 and 1939 sport fishery of Lake Winnibigoshish and connecting waters with special emphasis on the walleye population and catch. Minn. Dep. Nat. Resour. Invest. Rep. No. 312.

Johnson, J. H. 1956. Spawning habits of the cisco, *Coregonus (Leucichthys) artedii* LeSueur, in Big Portage Lake, Livingston and Washtenaw Counties, Michigan. M.S. Thesis, Univ. Mich.

Johnson, L. D. 1958. Pond culture of muskellunge in Wisconsin. Wis. Dep. Nat. Resour. Tech. Bull. No. 17.

Johnson, M. G., J. H. Leach, C. K. Minns, and C. H. Olver. 1977. Limnological characteristics of Ontario Lakes in relation to associations of walleye (*Stizostedion vitreum vitreum*), northern pike (*Esox lucius*), lake trout (*Salvelinus namaycush*) and smallmouth bass (*Micropterus dolomieu*). J. Fish. Res. Board Can. 34(10):1592-1601.

Johnson, R. P. 1963. Studies on the life history and ecology of the bigmouth buffalo, *Ictiobus cyprinellus* (Valenciennes). J. Fish. Res. Board Can. 20(6):1397-1429.

Johnston, D. A. 1977. Population dynamics of walleye (*Stizostedion vitreum vitreum*) and yellow perch (*Perca flavescens*) in Lake St. Clair, especially during 1970-76. J. Fish. Res. Board Can. 34(10):1869-1877.

Jolliff, T. M., and T. H. Eckert. undated. Evaluation of present and potential sturgeon fisheries of the St. Lawrence River and adjacent waters. N.Y. Dep. Environ. Conserv., Cape Vincent Fish. Stn.

Jones, P. W., F. D. Martin, and J. D. Hardy. Jr. 1978. Development of fishes of the Mid-Atlantic Bight, an atlas of egg, larval and juvenile stages. U.S. Fish Wildl. Serv., Biolog. Serv. Prog.

Jordan, D. S. 1877. Scientific description of Ohio fishes. Ohio State Fish Comm., 1st Annu. Rep. (1875-1876):57-87.

Jordan, D. S. 1885a. The habits and the value for food of the American channel catfish (Ictalurus punctatus, Rafinesque). Bull. U.S. Fish Comm. 5:34.

Jordan, D. S. 1885b. Notes on fishes observed in Lake Superior. Bull. U.S. Fish Comm. 5:191-192.

Jordan, D. S., and B. W. Evermann. 1909. Descriptions of three new species of cisco or lake herring (Argyrosomus), from the Great Lakes of America, with a note on the species of whitefish. Proc. U.S. Natl. Mus. 36:165-172.

Jordan, D. S., and B. W. Evermann. 1911. A review of the salmonid fishes of the Great Lakes, with notes on the whitefishes of other regions. Bull. U.S. Bur. Fish. 29:1-42.

Jude, D. J. 1976a. Entrainment of fish larvae and eggs on the Great Lakes, with special reference to the D. C. Cook Nuclear Plant, southeastern Lake Michigan. Pages 177-199 in Loren D. Jensen, ed., 3rd Natl. Workshop on Entrainment and Impingement, Section 316(b)--Research and Compliance. Ecological Analysts, Inc.

Jude, D. J. 1976b. Fish. Append. B-4 of Environmental Operating Report, Indiana and Michigan Power Co., Donald C. Cook Nuclear Power Plant, Unit 1, July 1, 1975 through Dec. 31, 1975.

Jude, D. J. 1977. Fish. Append. B-4 of Environmental Operating Report, Indiana and Michigan Power Company, Donald C. Cook Nuclear Plant, Unit 1, Bridgeman, Mich., July 1, 1976 through Dec. 31, 1976.

Jude, D. J. 1978. Quarterly report, adult and juvenile fish, ichthyoplankton and benthos populations in the vicinity of the J. H. Campbell Power Plant, eastern Lake Michigan, 1978.

Jude, D. J., B. A. Bachen, G. R. Heufelder, H. T. Tin, M. H. Winnell, F. J. Tesar, and J. A. Dorrill. 1978. Adult and juvenile fish, ichthyoplankton and benthos populations in the vicinity of the J. H. Campbell Power Plant, eastern Lake Michigan. Univ. Mich., Great Lakes Res. Div. Spec. Rep. No. 65.

Jude, D. J., T. W. Bottrell, J. A. Dorr III, and T. J. Miller. 1973. Benton Harbor Power Plant limnological studies. Part XII. Studies of the fish population near the Donald C. Cook Nuclear Power Plant, 1972. Univ. Mich., Great Lakes Res. Div. Spec. Rep. No. 44.

Jude, D. J., F. J. Tesar, J. A. Dorr, T. J. Miller, P. J. Rago, and D. J. Stewart. 1975. Inshore Lake Michigan fish populations near the Donald C. Cook Nuclear Power Plant 1973. Univ. Mich., Great Lakes Res. Div. Spec. Rep. No. 52.

Jude, D. J., G. R. Heufelder, H. T. Tin, N. A. Auer, S. A. Klinger, P. J. Schneeberger, T. L. Rutecki, T. L. Madenjian, and P. J. Rago. 1979. Adult juvenile and larval fish in the vicinity of the J. H. Campbell Power Plant, eastern Lake Michigan, 1978. Univ. Mich., Great Lakes Res. Div.

Jude, D. J., F. J. Tesar, J. C. Tomlinson, T. J. Miller, N. J. Thurber, G. G. Godun, and J. A. Dorr III. 1979. Inshore Lake Michigan fish populations near the D. C. Cook Nuclear Power Plant during preoperational years--1973, 1974. Univ. Mich., Great Lakes Res. Div. Spec. Rep. No. 71.

Julien, H. 1967. Notes of interview conducted by H. A. Regier, June 10.

June, F. C. 1977. Reproductive patterns in seventeen species of warmwater fishes in a Missouri River reservoir. Environ. Biol. Fish. 2(3):285-296.

Karvelis, E. G. 1964. The true pikes. U.S. Fish Wildl. Serv. Fish. Leaf. 569.

Kaups, M. 1978. North shore commercial fishing, 1849-1870. Minn. Hist. 46(2):43-58.

Keeler, L. E. 1904. The Sandusky River. Ohio Archaeol. Hist. Publ. 13:191-246.

Keenleyside, M. H. A. 1978. Reproductive isolation between pumpkinseed (Lepomis gibbosus) and longear sunfish (Lepomis megalotis) (Centrarchidae) in the Thames River, southwestern Ontario. J. Fish. Res. Board Can. 35(1):131-135.

Keller, M. 1962. Lake Erie sport fishing survey. Ohio Dep. Nat. Resour., Div. Wildl., Publ. 316.

Keller, M. 1964a. Walleye fry sampling (Sandusky Bay). Ohio Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-1 and 2, Job No. 2, July 1, 1961 to June 30, 1963.

Keller, M. 1964b. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour., Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-2, Job No. 1, July 1, 1963-June 30, 1964.

Keller, M., and J. Manz. 1963. Walleye spawning area study in western Lake Erie. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Project No. F-35-R-1, Job No. 1, July 1, 1962-June 30, 1963.

Kelso, J. R. M. 1972. The structure of the Long Point Bay fisheries, 1971. Nanticoke Project, Ont. Min. Nat. Resour.

Kelso, J. R. M., and J. K. Leslie. 1979. Entrainment of larval fish by the Douglas Point Generating Station, Lake Huron, in relation to seasonal succession and distribution. J. Fish. Res. Board Can. 36(1):37-41.

Kendall, W. C. 1913. Fishes and fishing in Sunapee Lake. U.S. Bur. Fish. Doc. No. 783.

Kendall, W. C. 1918. The Rangeley Lakes, Maine; with special reference to the habits of the fishes, fish culture, and angling. Bull. U.S. Bur. Fish. 35:485-594.

Kendall, W. C. 1921. Further observations on Coulter's whitefish. Copeia 90:1-4.

Kennedy, W. A. 1957. Current fisheries research by Canadians on the Great Lakes. Trans. Am. Fish. Soc. 86:419-423.

Kernen, L. T. 1972. Intra-Department memorandum, Green Bay Station to Sawyer Harbor File--Door County. Wis. Dep. Nat. Resour., unpubl. data.

Kernen, L. 1979. Walleye assessment in Lake Michigan--Green Bay. Wis. Dep. Nat. Resour., Annu. Perf. Rep., Dingell-Johnson Proj. AFC 14, Seg. No. 3., July 1, 1978-June 30, 1979.

Kernen, L., and M. Hawley. 1978. The yellow perch in southern Green Bay. Agenda Item IV, Lake Michigan Comm. Meeting, Great Lakes Fish. Comm.

Kerr, J. W. 1874. II. Miscellaneous notes and correspondence relative to the whitefish. Rep. of the Comm. for 1872 and 1873. Rep. U.S. Comm. Fish Fish. (1872 and 1873):79-89.

Kerr, J. W., and F. W. Kerr. 1860-1898. Handwritten diary as fisheries investigators, 1860-1898. R. Ont. Mus., 18 vol., (transcribed notes by Christine Regier 1975-76).

Kettanek, A. (ed.) 1971. Troubled waters, Lake Erie, 1971. Prep. for: The Lake Erie Congress, Erie, Penn., July 12-14, 1971.

Keyes, C. M. 1894. The fishing industry of Lake Erie, past and present. Bull. U.S. Fish Comm. 13(1893):349-353.

Kiel, P. 1874. II. Miscellaneous notes and correspondence relative to the whitefish. Rep. U.S. Comm. Fish Fish. (1872 and 1873):79-89.

King, D. R., and G. S. Hunt. 1967. Effect of carp on vegetation in a Lake Erie marsh. J. Wildl. Manage. 31(1):181-188.

King, G., and B. Belonger. 1970. Progress report of fish management on Lake Superior 1969. Wis. Dep. Nat. Resour., Bayfield.

King, G. R., and B. L. Swanson. 1975. Status of Lake Superior fish stocks in Wisconsin waters of Lake Superior, 1974. Pages 39-57 in Minutes of the Lake Superior Comm. Meeting.

King, G., and L. Wiegert. undated. Prog. Rep. on Fish Management on the Great Lakes--1964. Wis. Dep. Nat. Resour.

King, L. E., Jr., and V. C. Applegate. 1969. Report on appearance of salmon in Hammond Bay of Lake Huron and of salmon runs in the Ocqueoc River, Presque Isle County, Michigan, 1969. U.S. Bur. Commer. Fish., Great Lakes Fish. Lab., Admin. Rep.

Kinney, E. C., Jr. 1950. The life history of the trout-perch, *Percopsis omiscomaycus* (Walbaum), in western Lake Erie. M.S. Thesis, Ohio State Univ.

Kinney, E. C., Jr. 1954. A life history study of the silver chub, *Hybopsis storeriana*, in western Lake Erie. Ph.D. Thesis, Ohio State Univ.

Kirsch, P. H. 1895. A report upon investigations in the Maumee River basin during the summer of 1893. Bull. U.S. Fish Comm. 14:315-337.

Kirsch, P. H., M. W. Fordice. 1889. A review of the American species of sturgeons (Acipenseridae). Proc. Acad. Nat. Sci. Philadelphia, Part II:245-257.

Kitchel, M., and R. G. Otto. 1974. Screen monitoring study. Pages 345-374 *in* Operational Environmental Monitoring in Lake Michigan near Zion Station, July 1973 through June 1974, Vol. III, Annu. Rep. to Commonwealth Edison Co., by Industrial Bio-Test Laboratories, Inc.

Kleinert, S. J., and D. Mraz. 1966. Life history of the grass pickerel, *Esox americanus vermiculatus*, in southeastern Wisconsin. Wis. Conserv. Dep. Tech. Bull. 37.

Klippart, J. H. 1877. History of Toledo and Sandusky fisheries. First Annu. Rep. Ohio State Fish Comm. (1875-1876):31-42.

Kmiotek, S. 1952. The Wolf River: walleye nursery. Wis. Conserv. Bull. 17(3):12-15.

Kmiotek, S., and R. Daly. 1957. Chequamegon Bay's sport fishing. Wis. Conserv. Bull. 22(11):24-26.

Knuth, P. D. 1976. Geographic areas of particular concern: areas of significant natural value within the Pennsylvania coastal zone of Lake Erie. Penn. Dep. of Environ. Resour.

Koelz, W. 1926. Fishing industry of the Great Lakes. Rep. U.S. Comm. Fish. (1925):553-617.

Koelz, W. 1929. Coregonid fishes of the Great Lakes. Bull. U.S. Bur. Fish. 43:297-643.

Korosa, B. 1979. St. Clair smallmouths. Mich. Out-of-Doors 33(6):22-24.

Koster, W. J. 1936. The life-history and ecology of the sculpins (Cottidae) of central New York. Ph.D. Thesis, Cornell Univ.

Kozopas, R., and J. Leslie. 1979. Larval fish entrainment at Lambton TGS--1978. Cen. Ther. Serv. Rep. No. 07015-8.

Kramer, R. H., and L. L. Smith. 1960a. Utilization of nests of largemouth bass, *Micropterus salmoids* by golden shiners, *Notemigonus crysoleucas*. Copeia 1960(1):73-74.

Kramer, R. H., and L. L. Smith, Jr. 1960b. First year growth of the largemouth bass, Micropterus salmoides (Lacepede), and some related ecological factors. Trans. Am. Fish. Soc. 89(2):222-233.

Kramer, R. H., and L. L. Smith, Jr. 1962. Formation of year classes in largemouth bass. Trans. Am. Fish. Soc. 91(1):29-41.

Krause, W., Jr. 1967. Notes of interview conducted by H. A. Regier, June 9.

Krecker, F. H. 1916. Sunfish nests of Beimiller's Cove. Ohio J. Sci. 16(4):125-135.

Krueger, J. F. 1976. Report to Northern Indiana Public Service Company, Hammond, Indiana, Dean H. Mitchell Station, Gary, Indiana, 316(b) demonstration.

Kumlien, L., and F. W. True. 1887. The fishing-grounds of the Great Lakes. Pages 117-131 in The Fisheries and Fishery Industries of the United States, Sect. III, by George Brown Goode.

Kwain, W. H. 1971. Life history of the rainbow trout (Salmo gairdneri) in Batchawana Bay, eastern Lake Superior. J. Fish. Res. Board Can. 28(5):771-775.

Kwain, W-H., and J. A. Chappel. 1978. First evidence for even-year spawning pink salmon, Oncorhynchus gorbuscha, in Lake Superior. J. Fish. Res. Board Can. 35(10):1373-1376.

Kynard, B. E. 1978. Breeding behavior of a lacustrine population of threespine sticklebacks (Gasterosteus aculeatus L.). Behaviour 67(3-4):178-207.

Laarman, P. W. 1971. Separation of genetic strains of Great Lakes fishes. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-32-R-1, Job. No. 1 and 2, July 1, 1969-June 30, 1970.

Lachner, E. A. 1952. Studies of the biology of the cyprinid fishes of the chub genus Nicomis of northeastern United States. Am. Midl. Nat. 48(2):433-466.

Lagler, K. F. 1948. Fish and fishing in Michigan. Published by the author; printed by Edward Bros., Inc., Ann Arbor, Mich.

Lagler, K. F., and C. Hubbs. 1943. Fall spawning of the mud pickerel, Esox vermiculatus LeSueur. Copeia 1943(2):131.

LaJeone, L. J. 1976. Fish population and life history. Pages 1-71 in Operational environmental monitoring program of Lake Michigan near the Kewaunee Nuclear Power Plant: Chemical and biological studies. January-December 1975, Fifth Annu. Rep. prep. for Wis. Publ. Serv. Corp. by NALCO Environ. Sci.

Lake, C. T. 1936. The life history of the fan-tailed darter, Catonotus flabellaris flabellaris (Rafinesque). Am. Midl. Nat. 17:816-830.

Lake Erie Research Unit Staff. 1977. Status of Ohio's Lake Erie fisheries. Ohio Dep. Nat. Resour., Div. Wildl.

Lake Erie Research Unit Staff. 1978. Status of Ohio's Lake Erie fisheries. Ohio Dep. Nat. Resour., Div. Wildl.

Lake Erie Fisheries Unit Staff. 1979. Status of Ohio's Lake Erie fisheries. Ohio Dep. Nat. Resour., Div. Wildl.

Lake Ontario Environmental Laboratory. 1977. Distribution and abundance of fish eggs and larvae at a southern nearshore site on Lake Ontario, 1974. LOTEL Rep. No. 200, submitted to Rochester Gas and Electric Corp. by Lake Ontario Environ. Lab., State Univ. N.Y.-Oswego.

Lam, C. N. H. 1977. Distribution and abundance of the early developmental phases of alewife Alosa pseudoharengus (Wilson) and other fishes in the Bay of Quinte. M.S. Thesis, Univ. Guelph.

Lamsa, A. 1961. Fish and lamprey movements in Silver Creek, Ontario. Fish. Res. Board Can., Prog. Reps. of Biol. Stn. and Technol. Unit, London, Ontario. 2:21-24.

Lamsa, A. 1963a. Downstream movements of brook sticklebacks, Eucalia inconstans (Kirtland), in a small southern Ontario stream. J. Fish. Res. Board Can. 20(2):587-589.

Lamsa, A. K. 1963b. A study of rainbow trout in Silver Creek, Ontario. M.S. Thesis, Univ. Western Ontario, London.

Langhurst, R. W. 1975a. Northern pike fry--west shore. Wis. Dep. Nat. Resour., Intra-Department memorandum, Green Bay Station.

Langhurst, R. W. 1975b. West shore northern pike spawning areas. Wis. Dep. Nat. Resour., Intra-Department memorandum, Green Bay Station.

Langlois, T. H. 1935. Notes on the spawning habits of the Atlantic smelt. Copeia 1935(3):141-142.

Langlois, T. H. 1941. Two processes operating for the reduction in abundance or elimination of fish species from certain types of water areas. Trans. North Am. Wildl. Conf. 6:189-201.

Langlois, T. H. 1944. Fish and farms suffer when the Maumee runs brown. Ohio Conserv. Bull. 8(10):4-5.

Langlois, T. H. 1945a. Water, fishes and cropland management. Trans. North Am. Wildl. Conf. 10:190-196.

Langlois, T. H. 1945b. Ohio's fish program. Ohio Div. Conserv. Nat. Resour.

Langlois, T. H. 1948. The herring of Lake Erie. Inland Seas 2(2):101--104.

Langlois, T. H. 1954. The western end of Lake Erie and its ecology. J. W. Edwards, Publ., Inc., Ann Arbor, Mich.

Langlois, T. H. 1965. Portage River watershed and fishery. Ohio Dep. Nat. Resour., Div. Wildl. Publ. W-130.

Lapworth, E. D. 1956. The effect of fry plantings on whitefish production in eastern Lake Ontario. J. Fish. Res. Board Can. 13(4):547-558.

Lark, J. G. I. 1973. An early record of the sea lamprey (Petromyzon marinus) from Lake Ontario. J. Fish. Res. Board Can. 30(1):131-133.

Larmoyeux, J. D. 1951. Further investigations of the age and growth of the sheepshead Aplodinotus grunniens Rafinesque, in Lake Erie. M.S. Thesis, Univ. Mich.

Larsen, A. 1952. Operation "GAR" in Presque Isle Bay. Pa Angler 21(9):9.

Larson, G. L. 1976. Social behavior and feeding ability of two phenotypes of Gasterosteus aculeatus in relation to their spatial and trophic segregation in a temperate lake. Can. J. Zool. 54(2):107-121.

Latta, W. C. 1954. Some observations on the spawning of the smallmouth bass, Micropterus d. dolomieu, in Lake St. Clair during the spring of 1953. Mich. Dep. Conserv., Inst. Fish. Res. Rep. No. 1419.

Latta, W. C. 1957. The ecology of the smallmouth bass, Micropterus d. dolomieui Lacepede, at Waugoshance Point, Lake Michigan. Ph.D. Thesis, Univ. Mich.

Latta, W. C. 1963. The life history of the smallmouth bass, Micropterus d. dolomieui, at Waugoshance Point, Lake Michigan. Mich. Dep. Conserv., Bull. Inst. Fish. Res. No. 5.

Latta, W. C. 1969. Factors influencing size of year class in young-of-the-year bluegills. Mich. Dep. Nat. Resour., Job Completion Rep., Dingell-Johnson Proj. No. F-29-R-2, Job No. 8, July 1, 1967-June 30, 1968.

Latta, W. C. 1974. Fishing regulations for largemouth bass in Michigan. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1818.

Latta, W. C. 1975. Fishing regulations for smallmouth bass in Michigan. Mich. Dep. Nat. Resour., Fish. Res. Rep. 1834.

Lauer, G. J., W. T. Waller, D. W. Bath, W. Meeks, R. Heffner, T. Ginn, L. Zubarik, P. Bibko, and P. C. Storm. 1974. Entrainment studies on Hudson River organisms. Pages 37-82 in Proc. 2nd Workshop on Entrainment and Intake Screening, L. D. Jensen, ed., Rep. No. 15, Edison Electric Institute, Cooling Water Discharge Res. Proj. (RP-49) and Md. Power Plant Siting Program.

Laundergan, J. C. 1976. "Who catches smelt?" Published as a cooperative info. service of the Minn. Marine Advisory Service, and the Lake Superior Basin Studies Center, Univ. Minn., Duluth.

Lavis, D. S. 1976. Distribution of fish populations near a thermal discharge into western Lake Erie. M.S. Thesis, Mich. State Univ.

Lawler, G. H. 1965. Fluctuations in the success of year-classes of whitefish populations with special reference to Lake Erie. J. Fish. Res. Board Can. 22(5):1197-1227.

Lawler, Matusky and Skelly Engineers. 1975a. Impingement studies at Nine Mile Point Nuclear Station for Niagara Mohawk Power Corporation, Syracuse, New York.

Lawler, Matusky and Skelly Engineers. 1975b. 1974 Nine Mile Point aquatic ecology studies, LMS Project Nos. 191-21, 22, 23, for Niagara Mohawk Power Corp. and Power Authority of the State of New York.

Lawler, Matusky and Skelly Engineers. 1975c. 316(a) demonstration submission: NPDES permit NY0001015: Nine Mile Point Unit 1. Prepared for Niagara Mohawk Power Corp. LMSE-80/0131 and 395/001 for N.Y. State Dep. of Public Service.

Lawler, Matusky and Skelly Engineers. 1976a. 1974 Oswego Steam Station aquatic ecology studies, LMS Project Nos. 191-024, 025, 026.

Lawler, Matusky and Skelly Engineers. 1976b. 1975 Nine Mile Point aquatic ecology studies, LMS Project Nos. 191-031, 032, 033.

Lawler, Matusky and Skelly Engineers. 1977. Lake Ontario and St. Lawrence River ecosystems and power plant impacts. LMSE-77/0051 and 273/002 for Empire State Electric Energy Research Corp.

Lawler, Matusky and Skelly Engineers. 1977b. Oswego Steam Station--Unit 5, aquatic ecology studies 1975-1976, LMS Proj. Nos. 191-037, 038.

Lawler, Matusky and Skelly Enginers. 1977c. 1976 annual interpretative report Nine Mile Point aquatic ecology studies Vols. I and II. Prepared for Niagara Mohawk Power Corp. LMSE-80/0131 and 385/001 for N.Y. State Dep. of Public Service.

Lawler, Matusky and Skelly Engineers. 1977d. 1976 Nine Mile Point aquatic ecology studies. 2 vols. Prepared for Niagara Mohawk Power Corp. and Power Authority of the State of New York. LMSE-80/0131 and 395/001 for N. Y. State Dep. of Public Service.

Lawler, Matusky and Skelly Engineers. 1979. Fish residency and spawning activity in power plant discharges. Prep. for Ont. Hydro. LMSE-80/1031 and 395/001 for N. Y. State Dep. of Public Service.

Lawrie, A. H. 1954. Report on the operation of electrical barriers in the Sault Ste. Marie district. Append. 8, in Annu. Rep. to the Great Lakes Res. Comm., 1954, Sect. II.

Lawrie, A. H. 1955a. Observations on ammocoetes near Sault Ste. Marie during the summer of 1955. Append. I, pages 64-70, in Annu. Rep. to the Great Lakes Res. Comm., 1955, Sect. I.

Lawrie, A. H. 1955b. Assessment of Lake Superior tributaries for sea lamprey spawning. Append. No. 7 of Annu. Rep. to the Great Lakes Res. Comm., 1954.

Lawrie, A. H. The sea lamprey of the Great Lakes. Trans. Am. Fish. Soc. 99:766-775.

Lawrie, A. H. 1978. The fish community of Lake Superior. Great Lakes Res. 4(3-4):513-549.

Lawrie, A. H., and J. F. Rahrer. 1972. Lake Superior: effects of exploitation and introductions on the salmonid community. J. Fish. Res. Board Can. 29(6):765-776.

Lawrie, A. H., and J. F. Rahrer. 1973. Lake Superior, a case history of the lake and its fisheries. Great Lakes Fish. Comm. Tech. Rep. No. 19.

Leach, G. C. 1923. Artificial propagation of whitefish, grayling, and lake trout. U.S. Bur. Fish. Doc. No. 949. Append. III, Rep. U.S. Comm. Fish.

Leach, G. C. 1927. Artificial propagation of pike perch, yellow perch and pikes. Append. I to the Rep. U.S. Comm. Fish. for 1927, U.S. Bur. Fish. Doc. No. 1018.

Leach, G. C., and N. A. Borodin. 1920. Review of the techniques used in the artificial culture of lake sturgeon. Append. III to the Report of the U.S. Comm. Fish. for 1919-1920, U.S. Bur. Fish. Doc. No. 880.

Leach, G. C., M. C. James, and E. J. Douglas. 1941. Propagation and distribution of food fishes, fiscal year 1940. U.S. Dep. Int., Bur. of Fish., Append. IV to the Rep. Comm. Fish. for fiscal year 1940.

Leach, J. H., M. G. Johnson, J. R. M. Kelso, J. Hartmann, W. Numann, and B. Entz. 1977. Responses of percid fishes and their habitats to eutrophication. J. Fish. Res. Board Can. 34(10):1964-1971.

Leathers, A. L. 1911. Fish. Pages 243-255 in A biological survey of the sand dune region on the south shore of Saginaw Bay, Michigan. Mich. Geol. Biol. Surv. Publ. 4, Biol. Ser. 2.

Leitritz, E., and R. C. Lewis. 1976. Trout and salmon culture (hatchery methods). Calif. Dep. Fish Game Bull. 164.

Lennon, R. E. 1955. Artificial propagation of the sea lamprey, Petromyzon marinus. Copeia 3:235-236.

Lenz, G. 1947. Propagation of catfish. Prog. Fish Cult. 9(4):231-233.

Leslie, J. K., J. R. M. Kelso. 1977. Influence of a pulp and paper mill effluent on aspects of distribution, survival and feeding of Nipigon Bay, Lake Superior, larval fish. Bull. Environ. Contam. Toxicol. 18(5):602-610.

Leslie, J. K., R. Kozopas, and W. H. Hyatt. 1979. Considerations of entrainment of larval fish by a St. Clair River, Ontario, power plant. Can. Fish Mar. Serv. Tech. Rep. No. 868.

Lievense, S. J. 1954. Spawning of American smelt (Osmerus mordax) in Crystal Lake, Benzie County, Michigan. Copeia 1954(3):232-233.

Limnetics, Inc. 1974. An environmental study of the ecological effects of the thermal discharges from Point Beach, Oak Creek, and Lakeside Power Plants on Lake Michigan.

Liston, C. R. 1976. Estimates of salmonid mortalities occurring at the Ludington Pumped Storage Facility during 1975 and 1976, and related studies. 1976 Annu. Rep., Ludington Proj., Fish. Res., Vol. I, No. 1.

Liston, C. R., and P. I. Tack. 1972. A study of the effects of installing and operating a large pumped storage project on the shores of Lake Michigan near Ludington, Michigan. 4th Rep.

Liston, C. R., and P. I. Tack. 1973. A study of the effects of installing and operating a large pumped storage project on the shores of Lake Michigan near Ludington, Michigan. Final Rep.

Liston, C. R., and P. I. Tack. 1974. A study of the effects of installing and operating a large pumped storage project on the shores of Lake Michigan near Ludington, Michigan. 1973 Annu. Rep., Vol. I, Fish. Res.

Liston, C. R., and P. I. Tack. 1975. A study of the effects of installing and operating a large pumped storage project on the shores of Lake Michigan near Ludington, Michigan. 1974 Annu. Rep., Vol. I, Fish. Res.

Liston, C. R., D. Brazo, J. Bohr, R. Ligman, R. O'Neal, and G. Peterson. 1978. Preliminary report on progress of the 1978 aquatic research at the Ludington Pumped Storage Power Plant on Lake Michigan. 1978 Annu. Rep., Ludington Proj., Vol. I, No. 1., Dep. Fish. Wildl., Mich. State Univ., Ludington Res. Lab.

Loeb, H. A. 1953. Narrative report on rainbow trout in St. Marys River and the effect of regulated Lake Superior discharges on the river as a trout habitat.

Loeb, H. A., and A. E. Hall, Jr. 1952. Sea lamprey spawning: Michigan streams of Lake Superior. U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. 70.

Loftus, D. H. 1977. Larval fish sampling in Lake Huron, 1977. Ont. Min. Nat. Resour., Lake Huron Assess., Unit, unpubl. rep.

Loftus, K. H. 1948. Report on bass in Rondeau Bay. Ont. Min. Nat. Resour.

Loftus, K. H. 1950. The sea lamprey in Ontario. Sylva 6(3):25-35.

Loftus, K. H. 1952. The status of the Lake Superior fishery. Ont. Min. Nat. Resour.

Loftus, K. H. 1954a. Sea lamprey and lake trout work, 1954, Sault Ste. Marie district. Append. No. 13, _in_ Annu. Rep. to the Great Lakes Res. Comm., 1954, Sect. 2.

Loftus, K. H. 1954b. Progress report on research on the Lake Superior lake trout fishery in the Sault Ste. Marie and White River districts. Ont. Min. Nat. Resour.

Loftus, K. H. 1955. Sea lamprey and lake trout work, 1954, Sault Ste. Marie district. Append. No. 13, _in_ Annu. Rep. to the Great Lakes Comm., 1954.

Loftus, K. H. 1958. Studies on river-spawning populations of lake trout in eastern Lake Superior. Trans. Am. Fish. Soc. 87:259-277.

Ludwig, G. M., and C. R. Norden. 1969. Age, growth, and reproduction of the northern mottled sculpin (_Cottus bairdi bairdi_) in Mt. Vernon Creek, Wis. Milwaukee Public Mus. Occas. Pap. Nat. Hist. No. 2.

Lydell, D. 1903. Habits and culture of the black bass. U.S. Fish Comm. Bull. 22:39-44.

Lyons, W. W. 1972. Comments of Department of the Interior, Office of the Secretary. As seen in: U.S. Atomic Energy Comm., Final Environmental Statement--related to the operation of Enrico Fermi Atomic Power Plant, Unit 2, Detroit Edison Co., Docket No. 50-341.

MacCallum, W. R., and H. A. Regier. 1970. Distribution of smelt, Osmerus mordax, and the smelt fishery in Lake Erie in the early 1960s. J. Fish. Res. Board Can. 27(10):1823-1846.

MacCrimmon, H. R., and B. L. Gots. 1972. Rainbow trout in the Great Lakes. Publ. by Ont. Min. Nat. Resour., Sport Fish. Branch.

MacDonald, G. A. 1978. The Saulteur-Ojibwa fishery at Sault Ste. Marie, 1640-1920. M.A. Thesis, Univ. Waterloo, Ontario.

MacKay, H. H. 1931. The maskinonge and its conservation. Ont. Dep. Game Fish., Biol. and Fish Cult. Br., Bull. No. 1.

MacKay, H. H. 1956a. The spring salmon. Sylva 12(6):25-33.

MacKay, H. H. 1956b. The lake trout. Sylva 12(3):25-28.

MacKay, H. H. 1956c. The maskinonge. Sylva 12(4):25-32.

MacKay, H. H. 1956d. The eastern brook trout. Sylva 12(5):25-31.

MacKay, H. H. 1957a. The burbot (Lota lota). Sylva 13(4):25-31.

MacKay, H. H. 1957b. The black crappie. Sylva 13(1):25-27.

MacKay, H. H. 1957c. Brown trout. Sylva 13(2):25-31.

MacKay, H. H. 1957d. Brown bullhead. Sylva 13(3):25-28.

MacKay, H. H. 1957e. Longnose gar. Sylva 13(5):30-33.

MacKay, H. H. 1957f. The lake whitefish. Sylva 13(6):25-32.

MacKay, H. H. 1958a. The American smelt. Sylva 14(2):25-33.

MacKay, H. H. 1958b. The bowfin. Sylva 14(1):25-30.

MacKay, H. H. 1958c. White bass. Sylva 14(3):25-29.

MacKay, H. H. 1958d. Rock bass. Sylva 14(4):25-27.

MacKay, H. H. 1958e. Yellow pike perch. Sylva 14(6):25-31.

MacKay, H. H. 1959a. White sucker. Sylva 15(1):25-27.

MacKay, H. H. 1959b. Lake sturgeon. Sylva 15(2):25-33.

MacKay, H. H. 1959c. Pumpkinseed. Sylva 15(3):25-29.

MacKay, H. H. 1959d. Shallow water cisco. Sylva 15(4):25-34.

MacKay, H. H. 1959e. Yellow perch. Sylva 15(5):25-30.

MacKay, H. H. 1959f. Northern pike. Sylva 15(6):25-33.

MacKay, H. H. 1960a. Rainbow trout, Salmo gairdneri. Sylva 16(3):25-34.

MacKay, H. H. 1960b. Atlantic salmon. Sylva 16(6):25-38.

MacKay, H. H. 1960c. Carp. Sylva 16(2):25-34.

MacKay, H. H. 1960d. Smallmouth black bass. Sylva 16(4):25-34.

MacKay, H. H. 1960e. Largemough black bass. Sylva 16(5):25-31.

MacKay, H. H. 1969. Fishes of Ontario. Ont. Dep. Lands For.

MacKay, H. H., and E. MacGillivray. 1949. Recent investigations on the sea lamprey, Petromyzon marinus, in Ontario. Trans. Am. Fish. Soc. 76:148-159.

MacLean, J. A., and J. H. Gee. Effects of temperature on movements of prespawning brook sticklebacks, Culaea inconstons, in the Roseau River, Manitoba. J. Fish. Res. Board Can. 28:919-923.

MacLean, N. G., and G. C. Teleki. 1977. Homing behavior of rock bass (Ambloplites rupestris) in Long Pt. Bay, Lake Erie. J. Great Lakes Res. 3(3-4):211-214.

MacMillan, J. R. 1976. Larval fish sampling and population distributions relevant to estimating power plant entrainment in western Lake Erie. M.S. Thesis, Mich. State Univ.

McCormick, J. H., B. R. Jones, and R. F. Syrett. 1971. Temperature requirements for growth and survival of larval ciscoes (Coregonus artedii). J. Fish. Res. Board Can. 28(6):924-927.

McCormick, L. M. 1892. Descriptive list of the fishes of Lorain County, Ohio. Oberlin College, Lab. Bull. No. 2.

McCrimmon, H. R. 1950. The reintroduction of Atlantic salmon into tributary streams of Lake Ontario. Trans. Am. Fish. Soc. 78:128-132.

McCrimmon, H. R. 1951. Atlantic salmon in tributary streams of Lake Ontairo. Sylva 7(4):3-9.

McCrimmon, H. R. 1954. Stream studies on planted salmon. J. Fish. Res. Board Can. 11(4):362-403.

McCrimmon, H. R. 1956. Fishing in Lake Simcoe. Ont. Dep. Lands For.

McCrimmon, H. R. 1958. Observations on the spawning of the lake trout, Salvelinus namaycush, and the post-spawning movement of adult trout in Lake Simcoe. Can. Fish Cult. 23:3-11.

McCrimmon, H. R. 1959. Observations on spawning of burbot in Lake Simcoe, Ontario. J. Wildl. Manage. 23(4):447-449.

McCrimmon, H. R. 1968. Carp in Canada. Fish. Res. Board Can. Bull. 165.

McCrimmon, H. R., and O. E. Devitt. 1954. Winter studies on the burbot, *Lota lota lacustris* of Lake Simcoe, Ontario. Can. Fish Cult. 16:34-41.

McCrimmon, H. R., and U. B. Swee. 1967. Scale formation as related to growth and development of young carp, *Cyprinus carpio* L. J. Fish. Res. Board Can. 24(1):47-51.

McKenzie, J. A. 1974. The parental behavior of the male brook stickleback *Culaea inconstans* (Kirkland). Can. J. Zool. 52:649-652.

McKenzie, J. A., and M. H. A. Kennleyside. 1970. Reproductive behavior of ninespine sticklebacks (*Pungitius pungitius*) in South Bay, Manitoulin Island, Ontario, Canada. Can. J. Zool. 48(1):55-61.

McLeod, L. 1953. Wisconsin's fresh water sheepshead. Wis. Conserv. Bull. 18(2):27-29.

McNamara, F. 1937. Breeding and food habits of the pikes (*Esox lucius* and *Esox vermiculatus*). Trans. Am. Fish. Soc. 66:372-373.

Magnuson, J. L., and L. L. Smith. 1963. Some phases of the life history of the trout-perch. Ecology 44(1):83-95.

Mahon, R. 1977. Age and fecundity of the tadpole madtom, *Noturus gyrinus*, on Long Point, Lake Erie. Can. Field Nat. 91(3):292-294.

Mahon, R. 1979. The structure of fish communities in lakeshore lagoons on Long Point, Lake Erie, and their significance. Contact 11(1):19-36.

Mahon, R., and E. K. Balon. 1977a. Fish community structure in lakeshore lagoons on Long Point, Lake Erie, Canada. Environ. Biol. Fish. 2(1):71-82.

Mahon, R., and E. K. Balon. 1977b. Ecological fish production in Long Pond, a lakeshore lagoon on Long Point, Lake Erie. Environ. Biol. Fish. 2(3):261-284.

Mainville, F. 1980. Regional report, southern lower peninsula. Mich. Out-of-Doors 34(6):20.

Makarewicz, J. C., J. M. Haynes, and R. C. Dilcher. 1979. Aquatic biological survey, Oak Orchard Harbor, New York. Final rep. to the U.S. Army Corps of Eng., Buffalo Dist.

Maloney, J. E., and F. H. Johnson. 1955. Life histories and interrelationships of walleye and yellow perch, especially during their first summer, in two Minnesota lakes. Trans. Am. Fish. Soc. 85:191-202.

Manion, P. J. 1968. Production of sea lamprey larvae from nests in two Lake Superior streams. Trans. Am. Fish. Soc. 97(4):484-486.

Manion, P. J. 1972. Fecundity of the sea lamprey (Petromyzon marinus) in Lake Superior. Trans. Am. Fish. Soc. 101(4):718-720.

Manion, P. J. 1977. Downstream movement of fish in a tributary of southern Lake Superior. Prog. Fish Cult. 39(1):14-16.

Manion, P. J., and L. H. Hanson. 1980. Spawning behavior and fecundity of lampreys from the upper three Great Lakes. Can. J. Fish. Aquat. Sci. 37(11):1635-1640.

Manion, P. J., and A. L. McLain. 1971. Biology of larval sea lampreys (Petromyzon marinus) of the 1960 year class, isolated in the Big Garlic River, Michigan, 1960-65. Great Lakes Fish. Comm. Tech. Rep. No. 16.

Manion, P. J., and B. R. Smith. 1978. Biology of larval and metamorphosing sea lamprey (Petromyzon marinus) of the 1960 year class in the Big Garlic River, Michigan. Part II, 1966-72. Great Lakes Fish. Comm. Tech. Rep. No. 30.

Mansell, W. D. 1966. Brown trout in southwestern Ontario. Ont. Fish. Wildl. Res. 5(2):3-8.

Mansueti, A. J. 1964. Early development of the yellow perch, Perca flavescens. Chesapeake Sci. 5(1-2):46-66.

Mansueti, R. J. 1961. Movements, reproduction, and mortality of the white perch, Roccus americanus, in the Patuxent Estuary, Maryland. Chesapeake Sci. 2(3-4):142-205.

Manz, J. V. 1961. A preliminary survey of walleye pike spawning sites in western Lake Erie--1960. Ohio Div. Wildl.

Manz, J. 1963. Walleye fry sampling. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-1 and 2, Job No. 2, April 1, 1960-June 7, 1963.

Marean, J. B. 1976. The influences of physical, chemical, and biological characteristics of wetlands on their use by northern pike. M.S. Thesis, State Univ. N.Y.-Syracuse.

Marinac, P. 1976. The smallmouth bass population and fishery in a northern Wisconsin Lake, Clear Lake, Oneida County. M.S. Thesis, Univ. Wis.

Marine Studies Center. 1978. Horseshore reef. MSC Reef Survey, Univ. Wis.

Mark, E. L. 1890. Studies on Lepidosteus, part 1. Bull. Mus. Comp. Zool. (Harvard College) 19:1-127.

Markus, H. C. 1934. The fate of our forage fish. Trans. Am. Fish. Soc. 64:93-96.

Martin, N. V. 1955. The effect of drawdowns on lake trout reproduction and the use of artificial spawning beds. Trans. North Am. Wildl. Conf. 20:263-271.

Martin, N. V. 1957. Reproduction of lake trout in Algonquin Park, Ontario. Trans. Am. Fish. Soc. 86:231-244.

Martin, N. V. 1960. Homing behavior in spawning lake trout. Can. Fish. Cult. 26:3-6.

Martin, N. V. 1963. Lake trout spawning. Ont. Fish Wildl. Rev. 2(3):19-22.

Martin, N. V., and N. S. Baldwin. 1960. Observations on the life history of the hybrid between eastern brook trout and lake trout in Algonquin Park, Ontario. J. Fish. Res. Board Can. 17(4):541-551.

Martin, R. J. 1939a. Pine River perch run. Mich. Conserv. 8(10):3.

Martin, R. J. 1939b. Yellow pickerel run. Mich. Conserv. 8(9):6.

Marzolf, R. C. 1957. The reproduction of channel catfish in Missouri ponds. J. Wildl. Manage. 21(1):22-28.

Mason, E. J. R. 1933. Smelts in Lake Ontario. Copeia 1933(1):34.

Meehan, W. E. 1895. Fish, fishing and fisheries of Pennsylvania. Penn. State Comm. Fish, Off. Doc. 20:257-392.

Meehan, W. E. 1900. The history of the sturgeon. Rep. State Comm. Fish. (Penn.), Off. Doc. 17:225-250.

Meehan, W. E. 1910. Observations on smallmouth black bass in Pennsylvania during the spawning season of 1910. Trans. Am. Fish. Soc. 40:129-132.

Meek, S. E., and S. F. Hildebrand. 1910. A synoptic list of the fishes known to occur within 50 miles of Chicago. Field Mus. Nat. Hist. Publ. No. 142, Zool. Ser. 7(9):223-338.

Merna, J. W. 1979. Introduction of chlorinated hydrocarbons into stream fishes by spawning salmon. Mich. Dep. Nat. Res., Fish. Res. Rep. No. 1878.

Meyer, W. H. 1962. Life history of three species of redhorse (Moxostoma) in the Des Moines River, Iowa. Trans. Am. Fish. Soc. 91(4):412-419.

Meyer, L. P. 1967. A study of the northern hog sucker Hypentelium nigricans (LeSueur). Univ. Wis.-Stevens Point, unpublished MS.

Michigan Conservation. 1932a. Seven million perch planted. 2(2):4.

Michigan Conservation. 1932b. Plan noxious fish campaign. 2(4):3.

Michigan Conservation. 1932c. Smelt migrate to Lake Huron. 2(5):4.

Michigan Conservation. 1933. A review of recent activities in Michigan's conservation program. 3(4):5.

Michigan Conservation. 1934. Trout stripping continued on small scale to supplement propagation of imported eggs. 4(5):3.

Michigan Conservation. 1935a. Victim of violator. 5(2):8.

Michigan Conservation. 1935b. Fish and fisheries. 4(12):7.

Michigan Conservation. 1936a. Smelt. 5(9):2.

Michigan Conservation. 1946. Those reports of sea serpents indicate Great Lakes sturgeon staging comeback. 15(6):12.

Michigan Conservation. 1947. Walleyed pike fishing on Saginaw Bay is down. 16(6):15.

Michigan Department of Conservation. 1968a. Status of lake trout in Michigan offshore waters of Lake Superior, 1967. Append. IV in Minutes of Lake Superior Comm. Annu. Meet.

Michigan Department of Conservation. 1968b. Assessment of salmon and steelhead migrations, Huron River, Baraga County, Michigan, Fall, 1967. Append. VII in Minutes of Lake Superior Comm. Annu. Meet.

Michigan Department of Natural Resources. 1970. Coho salmon status report, 1967-68. Mich. Dep. Nat. Resour. Fish Manage. Rep. No. 3.

Michigan Department of Natural Resources. Unpublished computer printouts--trawl and gill net data from Lake Erie index stations. 1970-1976.

Michigan Department of Natural Resources. 1975. State of Michigan environmental impact statement, Dickinson Island Waterfowl Management Project involving low-level diking with appropriate water level control structures and pumps in St. Clair Flats Wildlife Area, Clay Township, St. Clair County.

Michigan Department of Natural Resources. undated. Comprehensive list of fish species collected in Lake St. Clair. MDNR survey, 1967-75.

Michigan Department of Natural Resources. 1976. A proposal to establish the St. Johns marshland recreation area.

Michigan Department of Natural Resources. 1977. State of Michigan environmental assessment for purchase and management of the St. John's Marsh wildlife area.

Michigan State Commissioners and Superintendent on State Fisheries. 1875. 1st report for 1873-4.

Michigan State Commissioners and Superintendent on State Fisheries. 1879. 3rd report for 1877-8.

Michigan State Board of Fish Commissioners. 1887. 7th biennial report, 1884-1886.

Michigan State Board of Fish Commissioners. 1888. 8th biennial report, 1886-1888.

Michigan State Board of Fish Commissioners. 1890. 9th biennial report, 1888-1890.

Michigan State Board of Fish Commissioners. 1893. 10th biennial report, 1890-1892.

Michigan State Board of Fish Commissioners. 1895. 11th biennial report, 1892-1894.

Michigan State Board of Fish Commissioners. 1897. 12th biennial report, 1894-1896.

Michigan State Board of Fish Commissioners. 1899. 13th biennial report, 1897-1898.

Michigan State Board of Fish Commissioners. 1905. 16th biennial report, 1903-1904.

Michigan State Board of Fish Commissioners. 1909a. 17th biennial report, 1905-1906.

Michigan State Board of Fish Commissioners. 1909b. 18th biennial report, 1907-1908.

Michigan State Board of Fish Commissioners. 1911. 19th biennial report, 1909-1910.

Michigan Water Resources Commission. 1974. Impact of the Karn and Weadock Plants' operation on water quality and biota in the Saginaw River and nearshore areas of Saginaw Bay, July 22, 1972 through May 6, 1973.

Michigan Water Resource Commission. 1975. Representative important species for use in 316 demonstrations for Michigan's electric generating facilities. pp. IV-I - IV-20 *in* Thermal and intake studies - guidance manual.

Mikol, G. F. 1978. Investigation of population dynamics of the lake-run rainbow trout (*Salmo gairdneri*) of the upper Niagara River and tributaries of eastern Lake Erie. M.A. Thesis, State Univ. N.Y., Buffalo.

Miller, B. R., and J. A. Scott. 1968. Assessment of salmon and steelhead migrations, Huron River, Baraga County, Michigan, Fall, 1967. Mich. Dep. Conserv., Fish Div., Baraga, Mich.

Miller, D. D. 1970a. The life history study of the burbot. Wyo. Game Fish Comm. Coop. Res. Proj. 5.

Miller, D. D. 1970b. A life history study of burbot in Boysen Reservoir, Ring Lake and Trail Lake. Wyo. Game Fish Comm., Completion rep., Dingell-Johnson Proj. No. F-41-R-2, Coop. Res. Proj. No. 5.

Miller, H. L. 1966. The old Au Sable. Wm. B. Eerdmans Publ. Co., Grand Rapids.

Miller, J. M. 1970. An analysis of the distribution of young-of-the-year brook trout, *Salvelinus fontinalis* (Mitchill), in Lawrence Creek, Wisconsin. Ph.D. Thesis, Univ. Wis.

Miller, N. J. 1952. Carp: control and utilization. Wis. Conserv. Bull. 17(5):3-7.

Miller, R. J. 1962. Reproductive behavior of the stoneroller minnow, *Campostoma anomalum pullum*. Copeia 1962(2):407-417.

Miller, R. J. 1964. Behavior and ecology of some North American cyprinid fishes. Am. Midl. Nat. 72(2):313-357.

Miller, R. R. 1957. Origin and dispersal of the alewife, *Alosa pseudoharengus*, and the gizzard shad, *Dorosoma cepedianum*, in the Great Lakes. Trans. Am. Fish. Soc. 97-111.

Miller, R. R. 1960. Systematics and biology of the gizzard shad (*D. cepedianum*) and related fishes. U.S. Fish Wildl. Serv. Fish. Bull. 173(60):371-392.

Milner, J. W. 1874a. I. Report on the fisheries of the Great Lakes; the result of inquiries prosecuted in 1871 and 1872. Pages 1-78 *in* Append. A. The fisheries of the Great Lakes and the species of *Coregonus* or whitefish. U.S. Comm. Fish Fish. Rep. 1872-1873.

Milner, J. W. 1874b. II. Miscellaneous notes and correspondence relative to the whitefish. Pages 79-89 *in* Append. A. The fisheries of the Great Lakes and the species of *Coregonus* or whitefish. U.S. Comm. Fish Fish. Rep. 1872-1873.

Milner, J. W. 1874c. The progress of fish culture in the United States. Pages 523-558 *in* Append. D. Fish-culture (The history, theory, and practice of fish-culture). U.S. Comm. Fish Fish. Rep. 1872-1873.

Minckley, W. L. 1963. The ecology of a spring stream Doe Run, Meade County, Kentucky. Wildl. Monogr. 11:3-124.

Minckley, W. L., and J. E. Deacon. 1959. Biology of the flathead catfish in Kansas. Trans. Am. Fish. Soc. 88(4):344-55.

Minnesota Department of Natural Resources. undated. Historical data on egg collections, 1937-1959.

Minnesota Department of Natural Resources. 1946. 1946 investigation--Lake Superior herring.

Minnesota Department of Natural Resources. 1975. Status of Lake Superior salmonids in Minnesota waters. Append. IV, pages 27-38 in Minutes of Lake Superior Comm. Annu. Meet.

Minnesota Division of Fish and Game. 1963. Life history and exploitation of the Lake Superior steelhead in Minnesota. Dingell-Johnson Proj. No. F-20-R-3 and 4, Job No. 3, March 1962 through December 1963.

Minnesota Power and Light Company. 1977. Report on 316(b) entrainment-impingement studies performed at Minnesota Power and Light Company's M. L. Hibbard Steam Electric Station. Data collected by Bioecological Consultants, Inc., Deer River, Minn.

Minor, J. D., and E. J. Crossman. 1978. Home range and seasonal movements of muskellunge as determined by radiotelemetry. Pages 146-153 in Selected Coolwater Fishes of North America, R. L. Kendall, ed., Am. Fish. Soc. Spec. Publ. No. 11.

Moenig, J. undated. The lake trout of Lake Erie: a historical review.

Moffett, J. W. undated. Hatchery production for rehabilitation of lake trout stocks in the Great Lakes. Unpubl. MS.

Moffett, J. W. 1954. Rainbow trout in St. Marys River. Regulated Lake Superior discharges and their effect on the river, especially the rapids section, as a trout habitat. U.S. Bur. Commer. Fish., Great Lakes Fish. Lab., unpublished admin. rep.

Moffett, J. W. 1956. The lake trout--endangered in the Great Lakes. Pages 23-24 in Our Endangered Wildl., Natl. Wildl. Fed., Wash., D.C.

Moffett, J. W. 1958. Trout in the Great Lakes. U.S. Trout News 3(3):8-10.

Moffett, J. W. 1966a. Ecology of the alewife (Alosa pseudoharengus) in the Great Lakes. Great Lakes Fish. Lab., admin. rep., March 1966.

Moffett, J. W. 1966b. The general biology of the cyclostomes with special reference to the lamprey. Pages 259-262 in Phylogeny of Immunity, R. T. Smith, P. A. Miescher, and R. A. Goode, eds., Univ. Fla. Press.

Momot, W. T., F. Stevenson, and J. Erickson. 1977. Maintenance of a walleye, (Stizostedion vitreum vitreum), fishery in a eutrophic reservoir. J. Fish. Res. Board Can. 34(10):1725-1733.

Moore, E. 1922. The primary sources of food of certain food and game, and bait fishes, of Lake George. Pages 52-63 in A biological survey of Lake George, N.Y., by J. G. Needham, C. Juday, E. Moore, C. K. Sibley, and J. W. Titcomb. N.Y. Conserv. Comm., Albany.

Moore, H. F. 1894. Report upon the condition and regulation of the fisheries of Lake Erie. Resume of observations. Joint Fisheries Comm.

Moore, H. H., and R. A. Braem. 1965. Distribution of fishes in U.S. streams tributary to Lake Superior. U.S. Fish Wildl. Serv., Spec. Sci. Rep.-Fish. No. 516.

Moore, J. 1970. Lake trout--Lake Michigan 1970. Wis. Dep. Nat. Resour.

Morgan, D. W. 1978a. A study of the effect of the NIPSCO Michigan City Generating Station on salmonid migrations in Trail Creek. Report on the effects of impingement and entrainment. Fourth Biannu. Rep.

Morgan, D. W. 1978b. A study of the effect of the NIPSCO Michigan City Generating Station on salmonid migrations in Trail Creek. Fifth Biannu. Rep.

Morgan, D. W. 1978c. A study of the effect of the NIPSCO Michigan City Generating Station on salmonid migrations in Trail Creek. Final Rep. for Northern Indiana Public Service Co.

Morgan, G. D. 1951. A comparative study of the spawning periods of the bluegill, Lepomis macrochirus, the black crappie, Pomoxis nigro-maculatus (LeSueur), and the white crappie, Pomoxis annularis (Rafinesque) of Buckeye Lake, Ohio. J. Sci. Lab. Denison Univ. 42(Arts. 1-14):112-118.

Morgan, G. D. 1954. Life history of the white crappie, Pomoxis annularis, of Buckeye Lake, Ohio. J. Sci. Lab. Denison Univ. 43(Arts. 6, 7, and 8):113-144.

Morman, R. H. 1979. Distribution and ecology of lampreys in the lower peninsula of Michigan, 1957-75. Great Lakes Fish. Comm. Tech. Rep. No. 33.

Morman, R. H., D. W. Cuddy, and P. C. Rugen. 1980. Factors influencing the distribution of sea lamprey (Petromyzon marinus) in the Great Lakes. Can. J. Fish. Aquat. Sci. 37(11):1811-1826.

Morris, D. 1958. The reproductive behavior of the tenspined stickleback (Pygosteus punitius L.). Behavior Suppl. 6:1-154.

Moyle, P. B. 1973. Ecological segregation among three species of minnows (Cyprinidae) in a Minnesota Lake. Trans. Am. Fish. Soc. 102(4):794-805.

Mraz, D. 1952. Movements of yellow perch marked in southern Green Bay, Lake Michigan, in 1950. Trans. Am. Fish. Soc. 81:150-161.

Mraz, D. 1954. Carp vs. largemouth bass. Wis. Conserv. Bull. 19(4):18-20.

Mraz, D. 1960. Preliminary report on the Lake Geneva smallmouth bass studies (1958-1959). Wis. Conserv. Dep., Fish Manage. Div., Res. Sect., Res. Rep. No. 1.

Mraz, D. 1964a. Age and growth of the round whitefish in Lake Michigan. Trans. Am. Fish. Soc. 93(1):46-52.

Mraz, D. 1964b. Observations on large and smallmouth bass nesting and early life history. Wis. Conserv. Dep., Res. Planning Div., Res. Rep. No. 11 (Fish.).

Mraz, D., and E. L. Cooper. 1957. Reproduction of carp, largemouth bass, bluegills, and black crappies in small rearing ponds. J. Wildl. Manage. 21(2):127-133.

Mraz, D., S. Kmiotek, and L. Frankenberger. 1963. The largemouth bass--its life history, ecology and management. Wis. Conserv. Dep. Publ. 232.

Muench, B. I. 1974. Adult fish study. Pages 141-200 in Operational environmental monitoring in Lake Michigan near Zion Station, July 1973 through June 1974, Vol. III, Annu. Rep. to Commonwealth Edison Co. by Industrial Bio-Test Laboratories, Inc.

Muench, B. 1979. Yellow perch assessment in Illinois waters, Lake Michigan 1976-1978. Ill. Dep. of Conserv., unpubl. rep.

Muench, B. 1979. Important fish species in the Illinois portion of Lake Michigan (as of 1979). Ill. Dep. of Conserv., Lake Michigan Invest.

Muenscher, W. C. 1929. VIII. Vegetation of the Niagara River and the eastern end of Lake Erie. Pages 189-197 in A biological survey of the Erie-Niagara System. Suppl. to 18th Annu. Rep., 1928, N.Y. Conserv. Dep.

Muenscher, W. C. 1931. V. Aquatic vegetation of the St. Lawrence watershed including the Grass, St. Regis, Salmon, Chateaugay systems and the St. Lawrence between Ogdensburg and the International Boundary. Suppl. to 20th Annu. Rep. 1930, N.Y. Conserv. Dep., Biol. Surv. (1930), No. V.

Muth, K. M. 1977. Status of major species in Lake Erie, 1976 commercial catch statistics, current studies and future plans. Append. VI, Pages 29-49, in Minutes (with append.) of Lake Erie Comm., 1977 Annu. Meet., Great Lakes Fish. Comm.

NALCO Environmental Sciences. undated (a). Report to Wisconsin Public Service Corporation, Green Bay, Wisconsin, J. P. Pulliam Power Plant, Green Bay, Wisconsin, 316(b) demonstration, environmental effects of existing cooling water intake structures.

NALCO Environmental Sciences. undated (b). Report to Wisconsin Public Service Corporation, Green Bay, Wisconsin, Kewaunee Nuclear Power Plant, Kewaunee, Wisconsin, 316(b) demonstration, environmental effects of existing cooling water intake structures.

NALCO Environmental Sciences. 1976a. Report to Northern Indiana Public Service Company, Hammond, Indiana, Dean H. Mitchell Station, Gary, Indiana, 316(a) demonstration.

NALCO Environmental Sciences. 1976b. Stateline Generating Station, Hammond, Indiana, 316(b) demonstration.

NALCO Environmental Sciences. 1977. Assessment of the yellow perch population of the lower Fox River and adjacent waters of Green Bay in the vicinity of the J. P. Pulliam Power Plant. Append. I *in* J. P. Pulliam power plant fish impingement, April 1977-December 1977.

NALCO Environmental Sciences. 1978. Spring census of larval fishes. Tech. rep. I *in* Environmental assessment, FY 1979 winter navigation demonstration on the St. Lawrence River, Tech. rep: Vol. II.

Nash, C. W. 1913. Fishes. Pages 249-271 *in* The Natural History of the Toronto Region, J. H. Faull, ed.

Needham, J. G. 1922. A biological reconnaissance of Lake George. Pages 8-36 *in* A biological survey of Lake George, N.Y., by J. G. Needham, C. Juday, E. Moore, C. K. Sibley, and J. W. Titcomb, N.Y. Conserv. Comm., Albany.

Nelson, D. D. 1975. The distribution and abundance of larval fishes along the western shore of Lake Erie at Monroe, Michigan. M.S. Thesis, Mich. State Univ.

Nelson, D. D., and R. A. Cole. 1975. The distribution and abundance of larval fishes along the western shore of Lake Erie at Monroe, Michigan. Mich. State Univ., Inst. Water Res., Tech. Rep. No. 32.4.

Nelson, E. W. 1878. Fisheries of Chicago and vicinity. U.S. Comm. Fish Fish. Rep. Comm. 1875-1876:783-800.

Nelson, J. S. 1968a. Life history of the brook silverside *Labidesthes sicculus*, in Crooked Lake, Indiana. Trans. Am. Fish. Soc. 97(3):293-296.

Nelson, J. S. 1968b. Deep-water ninespine sticklebacks, *Pungitius pungitius*, in the Mississippi drainage, Crooked Lake, Indiana. Copeia 1968(2):326-334.

Nelson, W. R. 1968. Reproduction and early life history of sauger, Stizostedion canadense, in Lewis and Clark Lake. Trans. Am. Fish. Soc. 97(2):159-166.

Nelson, W. R., N. R. Hines, and L. G. Beckman. 1965. Artificial propagation of saugers and hybridization with walleyes. Prog. Fish Cult. 27(4):216-218.

Nepszy, S. J. 1977. Changes in percid populations and species interactions in Lake Erie. J. Fish. Res. Board Can. 34(10):1861-1868.

Netsch, Lt. N. F., and A. Witt, Jr. 1962. Contributions to the life history of the longnose gar, (Lepisosteus osseus) in Missouri. Trans. Am. Fish. Soc. 91(3):251-262.

Nevin, J. 1896. Report of Superintendent. Pages 22-36 in 16th (7th Bienn.) Rep. Comm. Fish. Wis., 1895-1896.

Nevin, J. 1898. Artificial propagation versus a close season for the Great Lakes. Trans. Am. Fish. Soc. 27:17-26.

Nevin, J. 1899. Report of Superintendent. Pages 14-38 in Bienn. Rep. Comm. Fish. Wis., 1897-1898.

Nevin, J. 1901a. The propagation of muskellunge in Wisconsin. Trans. Am. Fish. Soc. (30):90-93.

Nevin, J. 1901b. Semi-annual report of Superintendent. Pages 11-33 in Bienn. Rep. Comm. Fish. Wis., 1899 and 1900.

Nevin, J. 1905. Report of Superintendent. Pages 20-26 in Bienn. Rep. Comm. Fish. Wis., 1903 and 1904.

Newburg, H. J. 1975. Evaluation of an improved walleye (Stizostedion vitreum) spawning shoal with criteria for design and placement. Minn. Dep. Nat. Resour., Completion Rep., Study 106, Dingell-Johnson Proj. No. F-26-R.

New York Conservation Department. 1921. 10th Annu. Rep. for 1920.

New York Conservation Department. 1929. 18th Annu. Rep. for 1928. Legis. Doc. (1929) No. 38.

New York Conservation Department. 1930. 19th Annu. Rep. for 1929. Legis. Doc. (1930) No. 38.

New York Conservation Department. 1931. 20th Annu. Rep. for 1930. Legis. Doc. (1931) No. 38.

New York Department of Environmental Conservation. undated. I love New York Great Lakes fishing.

New York Department of Environmental Conservation. 1977a. Lake Erie reports. Append. VIII, pages 75-87 in Minutes (with append.) of Lake Erie Comm., 1977 Annu. Meeting, Great Lakes Fish. Comm.

New York Department of Environmental Conservation. 1977b. Final report on significant coastal related fish and wildlife habitats of New York State. Div. Land Resour. For. Manage., Coastal Zone Manage. Study Program.

Niagara Mohawk Power Corporation. undated (a). 316(a) demonstration submission, Nine Mile Point Unit 1.

Niagara Mohawk Power Corporation. undated (b). Oswego Steam Station Units 1-4 316(a) demonstration submission.

Niagara Mohawk Power Corporation. undated (c). Oswego Steam Station Units 1-4 intake considerations.

Niagara Mohawk Power Corporation. undated (d). Nine Mile Point fish tagging program, 1974 annu. rep. Append. C in James A. Fitzpatrick Nuclear Power Plant 316(a) Demonstration Submission. Power Auth. State of N.Y.

Niagara Mohawk Power Corporation. 1973. Summary of studies to evaluate ecological effects from the introduction of a thermal discharge into Lake Ontario in the area of Nine Mile Point Nuclear Station Unit 1.

Niagara Mohawk Power Corporation. 1976. Application to the New York State Board on electric generation siting and the environment, Lake Erie generating station. Syracuse, N.Y.

Nichols, P. R. 1954. Observations of reproductive habits of the rock bass Ambloplites rupestris rupestris (Rafinesque). M.S. Thesis, Univ. Mich.

Niemuth, W. 1970. A study of migratory lake trout run in the Brule River, Wisconsin. Part II. Rainbow trout. Wis. Dep. Nat. Resour., Bur. Fish Manage., Manage. rep. no. 38.

Niemuth, W., W. Churchill, and T. Wirth. 1959. The walleye, its life history, ecology and management. Wis. Conserv. Dep. Publ. No. 227.

Noble, R. L. 1965. Life history and ecology of western blacknose dace, Boone Co., Iowa, 1963-1964. Iowa Acad. Sci. 72:282-293.

Noble, R. L. 1968. Mortality rates of pelagic fry of the yellow perch, Perca flavescens (Mitchill), in Oneida Lake, New York, and an analysis of the sampling problem. Ph.D. Thesis, Cornell Univ.

Noble, R. L. 1972. Distribution of walleye and yellow perch fry in a bay of Oneida Lake. N.Y. Fish Game J. 19(2):168-177.

Noble, R. L. 1975. Growth of young yellow perch (Perca flavescens) in relation to zooplankton populations. Trans. Am. Fish. Soc. 104(4):731-741.

Norby, R. D., and C. Collinson. 1977. A preliminary evaluation of Lake Michigan "reefs" in Illinois as potential breeding sites for indigenous fish species. In Third year work product, coastal geological studies, Ill. Coastal Zone Manage. Program.

Norden, C. R. 1967a. Age, growth and fecundity of the alewife, Alosa pseudoharengus (Wilson), in Lake Michigan. Trans. Am. Fish. Soc. 96(4):387-393.

Norden, C. R. 1967b. Development and identification of the larval alewife, Alosa pseudoharengus (Wilson), in Lake Michigan. Proc. Conf. Great Lakes Res. 10:70-78.

Norden, C. R. 1968. Morphology and food habits of the larval alewife, Alosa pseudoharengus (Wilson), in Lake Michigan. Proc. Conf. Great Lakes Res. 11:103-110.

Normandeau, D. A. 1969. Life history and ecology of the round whitefish Prosopium cylindraceum (Pallas), of Newfound Lake, Bristol, New Hampshire. Trans. Am. Fish. Soc. 98(1):7-13.

North Woods Call. 1979a. Steelhead runs improve, woodcock, robbins return. 23(51):1,8.

North Woods Call. 1979b. Smelt fail to make runs. 24(1):9.

North Woods Call. 1979c. Lakers home in an off-shore habitat. 24(1):9.

North Woods Call. 1979d. Steelhead winter victims. 24(2):1.

North Woods Call. 1979e. Permanent weir promised to block Jordan salmon. 24(5):3.

North Woods Call. 1979f. Bay de Noc walleyes coming back, but slow. 24(3):1,8.

North Woods Call. 1979g. Summer steelhead ignored. 24(7):6.

North Woods Call. 1979h. Pink salmon runs start. 24(9):2.

North Woods Call. 1979i. Pink salmon record falls. 24(10):11.

North Woods Call. 1979j. Pink salmon spread leads to questions about impacts. 24(11):1,8.

North Woods Call. 1979k. Keweenaw angling secrets uncovered. 24(13):1,8.

North Woods Call. 1979l. Nets may be used to control pinks. 24(13):5.

North Woods Call. 1979m. Happenings. 24(14):9.

North Woods Call. 1979n. Salmon draw outlaws tap trout streams; drop weirs. 24(14):1,8.

North Woods Call. 1980a. Eastern UP Outdoor report. 25(9):2.

North Woods Call. 1980b. Trophy brown trout peaking in Bay de Noc. 25(11):1.

North Woods Call. 1980c. Isle Royale last refuge for Great Lakes coasters. 25(11):7,9.

North Woods Call. 1980d. Biologists, anglers in stand-off over Manistee steelhead. 24(18):1,8.

North Woods Call. 1980e. Rifle River protection draws fire from locals; still time to comment. 24(3):5.

Nottingham, B. 1979. In the heart of the city! The Ann Arbor News, April 22, 1979.

Nsembukya-Katuramu, S. 1978. The Atlantic rainbow smelt, Osmerus mordax mordax, of Long Point area (Lake Erie, Ontario): a comparison of spawning, harvested and die-off stocks. M.S. Thesis, Univ. Toronto.

Nunan, P. J. Pink salmon in Lake Superior. Ont. Fish. Wildl. Rev. 6(3-4):9-14.

Nurnberger, P. K. 1931. Observations on the spawning temperature of Luxilus cornutis. Trans. Am. Fish. Soc. 61:215.

NUS Corporation, Cyrus Rice Div. 1973. 1971-1972 annual report for the aquatic ecological program at Perry site. Prep. for Cleveland Electric Illuminating Co. Append. B2.7 in Perry Nuclear Power Plant, Units 1 and 2, Environ. Rep., Constr. Permit Stage, Vol. 2.

NUS Corporation. 1975. Ichthyoplankton study report, 1974 data, Perry Nuclear Power Plant. Proj. No. 2065.

Odell, T. T. 1934. The life history and ecological relationships of the alewife (Pomolobus pseudoharengus [Wilson]) in Seneca Lake, N.Y. Trans. Am. Fish Soc. 64:118-126.

Odell, T. T. 1940. III. Bays and ponds of the shore area. Pages 82-97 in A biological survey of the Lake Ontario watershed. Suppl. to 19th Annu. Rep. (1939), State of N.Y. Conserv. Dep.

Odin, C. R. 1976. Letter to Colonel Bernard C. Hughes, U.S. Army, Corps of Engineers, District, Buffalo, June 18, 1975. Page A-4 in Append. A, Lett. of Coord. in Final Environ. Impact Statement, Oper. and Maint., Vermilion Harbor, Erie Co., Ohio. Prep. by U.S. Army Eng. Dist., Buffalo.

Odin, C. R. 1979. Letter to Col. Robert V. Vermillion, U.S. Army Engineer, Detroit District, November 2, 1979.

O'Donnell, D. J., and W. S. Churchill. 1954. Certain physical, chemical and biological aspects of the Bruce River, Douglas County, Wisconsin. Wis. Acad. Sci., Arts Lett. 43:201-255.

Oehmcke, A. A., L. Johnson, J. Klingbiel, and C. Wistrom. 1962. The Wisconsin muskellunge, its life history, ecology and management. Wis. Conserv. Dep. Publ. 225.

O'Gorman, R. 1975. Distribution of fish fry in the nearshore waters of western Lake Huron, May-June 1973. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., Admin. Rep.

O'Gorman, R. 1976. Distribution of fish fry in the nearshore waters of western Lake Huron, June-July 1974. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., Admin. Rep.

O'Gorman, R. 1978. Distribution of larval fish in the nearshore waters of western Lake Huron, April-August 1975, and an overview of 3 successive years of sampling. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., unpubl. rep.

O'Gorman, R. 1979. Distribution and abundance of larval fish in the nearshore waters of western Lake Huron. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab, draft manuscr.

Ohio Conservation Bulletin. 1939. Know your fish. 3(1):7.

Ohio Department of Natural Resources, Division of Wildlife. undated. The fishing potentials, special management areas, and their interaction with dredge spoil sites in Lake Erie. Prep. for Coastal Zone Manage. Program.

Ohio Department of Natural Resources. 1976. Maumee River basin level B study, baseline reference, environmental sector. Final rep., Great Lakes Basin Comm., MRB Ser. No. 9.

Ohio Edison Company. 1977. Environmental Report, construction permit stage, Erie Nuclear Plant Units 1 and 2. Vols. 1 and 2.

Ohio Environmental Protection Agency. 1976. Comments by the Ohio EPA submitted on July 26, 1976. Pages 127-131 in Rep. submitted pursuant to section 316(a) for the Avon Lake Electrical Generating Station of the Cleveland Electrical Illuminating Company.

Olson, D. 1970. Life history and relative abundance of three species of bullheads in Lake Sallie. Minn. Job Prog. Rep., Dingell-Johnson Proj. No. F-26-R-1, Study No. II, Job No. II-1, April 1, 1969-March 31, 1970.

best copy available

Olson, D. 1971. Life history and relative abundance of three species of bullheads in Lake Sallie. Minn. Job Prog. Rep., Dingell-Johnson Proj. No. F-26-R-2, Study No. II, Job No. II-1, April 1, 1970-March 31, 1971.

Olson, D. 1972. Life history and relative abundance of three species of bullheads in Lake Sallie. Minn. Job Prog. Rep., Dingell-Johnson Proj. No. F-26-R-3, Job No. II-1, April 1, 1971-March 31, 1972.

Olson, D. E. 1978. Measure effect of induced abandonment on bullhead nesting success and egg mortality. Minn. Div. of Fish and Wildl., Completion Rep., Dingell-Johnson Proj. No. F-26-R-9, Study 117, Job 1, April 15, 1977-March 31, 1978.

Olson, D. E., and L. J. Koopman. 1976. Interactions of three species of bullheads (under commercial exploitation) and associated panfishes in a eutrophic lake. Minn. Dep. of Nat. Resour., Div. Fish Wildl., Invest. Rep. No. 337. Completion Rep., Dingell-Johnson Proj. No. F-26-R, Study 102.

Olson, D. E., D. H. Schupp, and V. Macins. 1978. A hypothesis of homing behavior of walleyes as related to observed patterns of passive and active movement. Pages 52-57 In A symposium on selected coolwater fishes of North America, R. L. Kendall ed., Am. Fish. Soc. Spec. Publ. 11.

Olson, D. E., and W. J. Scidmore. 1962a. Homing behavior of spawning walleyes. Trans. Am. Fish. Soc. 91(4):355-361.

Olson, D. E., and W. J. Scidmore. 1962b. Homing tendency of spawning white suckers in Many Point Lake, Minnesota. Trans. Am. Fish. Soc. 92(1):13-16.

O'Mara, T. B. 1978. Population statistics and movement patterns of smallmouth bass (Micropterus dolomieu) in the upper Niagara River and adjacent Lake Erie (1975-1976). M.S. Thesis, State Univ. N.Y. -Buffalo.

Ontario Department of Fisheries. 1906. 7th Annual Report (1905).

Ontario Department of Lands and Forests. 1948. Report for the fiscal year ending March 31, 1947.

Ontario Department of Lands and Forests. 1950. Report for the fiscal year ending March 31, 1949.

Ontario Department of Lands and Forests. 1968. Annual report for the fiscal year ending March 31, 1968.

Ontario Department of Lands and Forests. 1969. Annual report for the fiscal year ending March 31, 1969.

Ontario Department of Lands and Forests. 1971. Annual report for the fiscal year ending March 31, 1971.

Ontario Game and Fisheries Department. 1908. First Annual Report (1907).

Ontario Game and Fisheries Department. 1909. Second Annual Report (1908).

Ontario Game and Fisheries Department. 1910. Third Annual Report (1909).

Ontario Game and Fisheries Department. 1911. Fourth Annual Report (1910).

Ontario Game and Fisheries Department. 1912. Fifth Annual Report (1911).

Ontario Game and Fisheries Department. 1913a. Sixth Annual Report (1912).

Ontario Game and Fisheries Department. 1913b. Seventh Annual Report (1913).

Ontario Game and Fisheries Department. 1915. Eighth Annual Report (1914).

Ontario Game and Fisheries Department. 1916. Ninth Annual Report (1915).

Ontario Game and Fisheries Department. 1917. Tenth Annual Report (1916).

Ontario Game and Fisheries Department. 1930. Twenty-third Annual Report (1929).

Ontario Game and Fisheries Department. 1931. Twenty-fourth Annual Report (1930).

Ontario Game and Fisheries Department. 1932. Twenty-fifth Annual Report (1931).

Ontario Game and Fisheries Department. 1933. Twenty-sixth Annual Report (1932).

Ontario Game and Fisheries Department. 1934. Twenty-seventh Annual Report (1933).

Ontario Game and Fisheries Department. 1935. Twenty-eighth Annual Report (1934).

Ontario Game and Fisheries Department. 1939. Thirty-first Annual Report (1937-1938).

Ontario Game and Fisheries Department. 1940. Thirty-second Annual Report (1938-1939).

Ontario Game and Fisheries Department. 1941. Thirty-third Annual Report (1939-1940).

Ontario Game and Fisheries Department. 1943. Thirty-fifth Annual Report (1941-1942).

Ontario Game and Fisheries Department. 1944. Thirty-sixth Annual Report (1942-1943).

Ontario Game and Fisheries Department. 1945. Thirty-seventh Annual Report (1943-1944).

Ontario Game and Fisheries Department. 1946. Thirty-eighth Annual Report (1944-1945).

Ontario Game and Fisheries Department. 1948. Thirty-ninth Annual Report (1945-1946).

Ontario Ministry of Natural Resources. undated. Fish Ontario. Fish. Branch, Div. Fish Wildl.

Ontario Ministry of Natural Resources. 1973. Trout and salmon migratory routes--southern Ontario streams. Map SF-1.

Ontario Ministry of Natural Resources. 1975a. Annual report of the Minister--1975.

Ontario Ministry of Natural Resources. 1975b. Append. II. A progress report by the Ontario Ministry of Natural Resources--Lake Superior Fisheries Assessment Unit. Pages 3-26 _in_ Minutes of Lake Superior Comm. 1975 Annu. Meet., Great Lakes Fish. Comm.

Ontario Ministry of Natural Resources. 1976a. Lake Ontario. Prep. for Interim Meet., Great Lakes Fish. Comm., Dec. 1976.

Ontario Ministry of Natural Resources. 1976b. Trout and salmon migratory routes--northern Ontario streams. Map SF-5.

Ontario Ministry of Natural Resources. 1977a. The Saugeen River fishery below Denny's Dam, creel census, fall 1977. Unpubl. rep.

Ontario Ministry of Natural Resources. 1977b. Lake Erie and Lake St. Clair Fisheries Report. Append. VII, pages 51-74 _in_ Minutes (with append.) of Lake Erie Comm. 1977 Annu. Meet., Great Lakes Fish. Comm.

Ontario Ministry of Natural Resources. 1978. Collecting salmon eggs. North Cent. Div., Am. Fish. Soc. Newsletter 89-90.

Organ, W. L., G. L. Towns, M. O. Walter, R. B. Pelletier, and D. A. Riege. 1978. Past and presently known spawning grounds of fishes in Michigan coastal waters of the Great Lakes. Draft. Mich. Dep. Nat. Resour. Fish. Div., Tech. Rep. No. 78-7.

Orpet, R. A., and M. C. Cochran. 1976. Fish impingement study at Waukegan Generating Station, May 1975-April 1976. NALCO Environ. Sci.

Osburn, R. C. 1901. The fishes of Ohio. Ohio Acad. Sci. Spec. Pap. No. 4.

Osburn, R. C. 1923. Natural and artificial conditions detrimental to the black basses. Trans. Am. Fish. Soc. 53:27-49.

Osburn, R. C., and E. B. Williamson. 1898. A list of the fishes of Franklin County, Ohio, with a description of a new species of Etheostoma. 6th Annu. Rep. Ohio State Acad. Sci.:11-20.

Otto, R. G. 1975. The effects of once-through cooling on fish eggs and larvae in southwestern Lake Michigan. Pages 57-235 in Operational environmental monitoring in Lake Michigan near Zion Station, July 1974 through June 1975., Vol. IV.

Otto, R. G., M. A. Kitchel, and J. O'H. Rice. 1976. Lethal and preferred temperatures of the alewife (Alosa pseudoharengus) in Lake Michigan. Trans. Am. Fish. Soc. 105(1):96-106.

Paine, J. R. 1976. Preliminary beach seine survey on the north shore of the western basin of Lake Erie. Ont. Min. Nat. Resour., Div. Fish Wildl.

Parker, J. B., E. B. Williamson, and R. C. Osborn. 1899. A descriptive list of the fishes of Big Jelloway Creek and tributaries, Knox County, Ohio. Annu. Rep. Ohio State Acad. Sci. 7:18-32.

Parker, R. O., Jr. 1964. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-1, Job. No. 3, Nov. 1960-Oct. 1962.

Parkhurst, B. R. 1971. An ecological evaluation of a thermal discharge. Part V: The distribution and growth of the fish populations along the western shore of Lake Erie at Monroe, Michigan during 1970. Mich. State Univ., Inst. Water Res. Tech. Rep. No. 17, Thermal Discharge Series.

Parsons, J. W. 1967. Contributions of year-classes of blue pike to the commercial fishery of Lake Erie, 1943-59. J. Fish. Res. Board Can. 24(5):1035-1066.

Parsons, J. W. 1970. Walleye fishery of Lake Erie in 1943-62 with emphasis on contributions of the 1942-61 year-classes. J. Fish. Res. Board Can. 27:1475-1489.

Parsons, J. W. 1971. Selective food preferences of walleyes of the 1959 year-class in Lake Erie. Trans. Am. Fish. Soc. 100(3):474-485.

Parsons, J. W. 1972. Life history and production of walleyes of the 1959 year-class in western Lake Erie, 1959-62. Trans. Am. Fish. Soc. 101(4):655-661.

Parsons, J. W. 1973. History of salmon in the Great Lakes, 1850-1970. U.S. Bur. Sport Fish. Wildl. Tech. Pap. No. 68.

Parsons, J. W. 1975. Compilations on salmon and trout of Lake Michigan. Append. III[B], pages 11-31 in Minutes (with append.) of Lake Michigan Comm. 1975 Annu. Meet., Great Lakes Fish. Comm.

Pasko, D. G. 1956. Lake Ontario lake trout. N.Y. State Conserv. 10(4):16-17.

Passino, D. R. May, and J. M. Kramer. 1980. Toxicity of arsenic and PCBs to fry of deepwater ciscoes (Coregonus). Bull. Environ. Contam. Toxicol. 24:527-534.

Patriarche, M. H. 1969. Effects of heated discharges from nuclear power plants on fish populations. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-32-R-1, Job No. 3., July 1, 1968-June 30, 1969.

Patriarche, M. H. 1971. Effects of heated discharges from nuclear power plants on fish populations. Mich. Dep. Nat. Res. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-28-R-4, Study No. I, July 1, 1969-June 30, 1970.

Patriarche, M. H. 1972a. Fish sampling at the Palisades Power Plant site in June 1972. 27 pp. in Fourth session of the conference in the matter of pollution of Lake Michigan and its tributary basin in the states of Wisconsin, Illinois, Indiana, and Michigan. Vol. III (part 2 of 3 parts).

Patriarche, M. H. 1972. Fish population survey at Palisades, and age and growth of yellow perch. Mich. Dep. Nat. Res. Annu. Prog. Rep., Dingell-Johnson, Proj. No. F-28-R-6, Study No. I, Job. No. I-1,2, July 1, 1970-June 30, 1971.

Patriarche, M. H. 1973a. Fish population surveys at the Palisades Power Plant in 1972. Pages 168-170 in Consumers Power Co., Semi-annu. operations Rep. No. 4, July 1-Dec. 31, 1972.

Patriarche, M. H. 1973b. Fish population survey at Palisades Power Plant, and age and growth of yellow perch. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-218-R-7, Study No. I, Job No. I-1,2, July 1, 1971-June 30, 1973.

Patriarche, M. H. 1974. Fish population survey at Palisades Power Plant, and age and growth of yellow perch. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-28-R-8, Study No. I, Job No. I-1,2, July 1, 1973-June 30, 1974.

Patriarche, M. H. 1975. Reaction of nearby Lake Michigan fish stocks to a heated discharge at the Palisades site. Mich. Dep. Nat. Resour., Fish Res. Rep. No. 1820.

Patterson, R. L. 1978. Production, mortality, and power plant cooling water entrainment of larval yellow perch in Michigan-Ohio waters of the western basin of Lake Erie in 1975 and 1976: impacts upon standing crop and the fishery. U.S. Environ. Prot. Agency, Large Lakes Res. Stn., Grosse Ile, Mich., School Nat. Resour.

Patterson, R. L. 1979a. Unpublished computer printout.

Patterson, R. L. 1979b. Production, mortality, and power plant entrainment of larval yellow perch in western Lake Erie. U.S. Environ. Prot. Agency, EPA-600/3-79-087.

Paul, J. F., and R. L. Patterson. 1977. Hydrodynamic simulation of movement of larval fishes in western Lake Erie and their vulnerability to power plant entrainment. 1977 Winter Simulation Conf. 1:305-316. H. J. Highland, R. G. Sargent, J. W. Schmidt, eds.

Paxton, K. O., and R. E. Day. 1974. An evaluation of the fisheries of upground reservoirs. Ohio Dep. Nat. Resour., Div. Wildl., Ohio Inland Fish. Res., Perf. Rep., Proj. No. F-29-R-13, July 1, 1973-June 30, 1974.

Payne, N. R. 1964. The life history of the walleye Stizostedion vitreum vitreum (Mitchill) in the Bay of Quinte. M.S. Thesis, Univ. Toronto.

Payne, N. R. 1966. A progress report on the Mississagi River walleye study. Ont. Min. Nat. Resour., unpubl.

Pearce, W. A., R. A. Braem, S. M. Dustin, and J. J. Tibbles. 1980. Sea lamprey (Petromyzon marinus) in the lower Great Lakes. Can. J. Fish. Aquat. Sci. 37(11):1802-1810.

Pearse, A. S. 1918a. The food of the shore fishes of certain Wisconsin lakes. Bull. U.S. Bur. Fish. 35:245-292.

Pearse, A. S. 1918b. The habits of the fishes of inland lakes. Sci. Monthly 6:355-361.

Pearse, A. S. 1919. Habits of the black crappie in inland lakes of Wisconsin. U.S. Bur. Fish. Doc. No. 867.

Pearse, A. S., and H. Achtenberg. 1920. Habits of yellow perch in Wisconsin lakes. Bull. U.S. Bur. of Fish. 36:297-366.

Peck, J. W. 1970. Straying and reproduction of coho salmon, Oncorhynchus kisutch, planted in a Lake Superior tributary. Trans. Am. Fish. Soc. 99(3):591-595.

Peck, J. W. 1974a. Migration, food habits, and predation on yearling coho salmon in a Lake Michigan tributary and bay. Trans. Am. Fish. Soc. 74(1):10-14.

Peck, J. W. 1974b. Find areas of lake trout spawning in Lake Michigan and Lake Superior and assess homing. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-31-R-8, Study No. V, Job No. 1, July 1, 1973-June 1974.

Peck, J. W. 1975a. Brief life history accounts of five commercial salmonid fishes in Lake Superior. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1821.

Peck, J. W. 1975b. Location of lake trout spawning in Lake Superior and Lake Michigan. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-1 (group 4), Study No. V, July 1, 1974-June 30, 1975.

Peck, J. W. 1976. Location of lake trout spawning in Lake Superior and Lake Michigan. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-2 (group 4), Study No. V, July 1, 1975-June 30, 1976.

Peck, J. W. 1977. Location of lake trout spawning in Lake Superior and Lake Michigan. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-3 (group 4), Study No. V, July 1, 1976-June 30, 1977.

Peck, J. W. 1978. Population dynamics of lake trout in early life history stages and characteristics of an artificial spawning reef. Mich. Dep. Nat. Resour. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-4 (group 4), Study No. 416, Oct. 1, 1977-Sept. 30, 1978.

Peck, J. W. 1979a. Utilization of traditional spawning reefs by hatchery lake trout in the upper Great Lakes. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1871.

Peck, J. W. 1979b. Population dynamics of lake trout in early life history stages and characteristics of an artificial reef. Mich. Dep. Nat. Resour. Annu. Rep., Dingell-Johnson Proj. No. F-35-R-5 (group 4), Study No. 416, Oct. 1, 1978-Sept. 30, 1979.

Peck, J. W., R. Schorfhaar, and A. T. Wright. 1974. Status of selected stocks in Lake Superior and recommendations for commercial harvest. Tech. rep. 73-33, pages 1-67 in Status of selected fish stocks in Michigan Great Lakes waters and recommendations for commercial harvest. Mich. Dep. Nat. Resour., Fish Div. Tech. Rep. 78-10, 11, 32 and 33. J. D. Bails and M. H. Patriarche, eds.

Peck, J., and T. Stauffer. 1968. Population dynamics of anadromous rainbow trout in a Lake Superior tributary. Mich. Dep. Conserv. Annu. Prog. Rep., Dingell-Johnson Proj. No. F-31-R-1, Job No. 4, July 1, 1966-June 30, 1967.

Peckham, R. S. 1955. Ecology and life history of the central mudminnow Umbra limi (Kirtland). Ph.D. Thesis, Univ. Notre Dame.

Peckham, R. S., and C. F. Dineen. 1957. Ecology of the central mudminnow, Umbra limi (Kirtland). Am. Midl. Nat. 58(1):222-231.

Peterka, J. J., and J. S. Kent. 1976. Dissolved oxygen, temperature, survival of young at fish spawning sites. U.S. Environ. Prot. Agency, EPA-600/3-76-113, Environ. Res. Lab.

Pfeiffer, R. A. 1955. Studies on the life history of the rosyface, Notropis rubellus. Copeia 1955(2):95-104.

Pflieger, W. L. 1960. Studies on the life history of the cyprinid fishes, Notropis spilopterus spilopterus (Cope) and Notropis whipplei (Girard). M.S. Thesis, Ohio State Univ.

Pflieger, W. L. 1965. Reproductive behavior of the minnows Notropis spilopterus and Notropis whipplei. Copeia 1965(1):1-8.

Pinsak, A. P., and T. L. Meyer. 1976. Environmental baseline for Maumee Bay. Great Lakes Basin Comm., MRB Ser. No. 9, Maumee River Basin Level B. Study.

Platts, W. S., M. A. Shirazi, and D. H. Lewis. 1979. Sediment particle sizes used by salmon for spawning with methods for evaluation. U.S. Environ. Prot. Agency EPA-600/3-79-043.

Poff, R. J., R. Gernay, and C. W. Threinen. 1964. Surface water resources of Ozaukee County. Wis. Conserv. Dep., Madison.

Poff, R. J., and C. W. Threinen. 1961a. Surface water resources of Racine County. Wis. Conserv. Dep., Madison.

Poff, R. J., and C. W. Threinen. 1961b. Surface water resources of Kenosha County. Wis. Conserv. Dep., Madison.

Poff, R. J., and C. W. Threinen. 1964. Surface water resources of Milwaukee County. Wis. Conserv. Dep., Madison.

Poff, R. J., and C. W. Threinen. 1965. Surface water resources of Door County. Wis. Conserv. Dep., Madison.

Poff, R. J., and C. W. Threinen. 1966. Surface water resources of Kewaunee County. Wis. Conserv. Dep., Madison.

Porter, T. R. 1972. Biology of kokanee salmon (Oncorhynchus nerka Walbaum) in Blue Jay Creek, Manitoulin Island, Ontario. M.S. Thesis, Univ. Guelph.

Post, H. 1890. General observations on lake sturgeon hatching. "The sturgeon; some hatching experiments." Trans. Am. Fish. Soc. 19:36-40.

Power Authority of the State of New York. undated (a). James A. Fitzpatrick Nuclear Power Plant 316(a) demonstration submission.

Power Authority of the State of New York. undated (b). James A. Fitzpatrick Nuclear Power Plant 316(b) demonstration submission.

Prepejchal, W. , G. P. Romberg, and S. A. Spigarelli. 1974. Effects of season, location, and discharge type on fish distribution and density in thermal plumes. Pages 150-154 in Radiological and Environmental Research Division Annu. Rep., Ecology, Jan.-Dec. 1974, ANL-75-3, Part III, Argonne Natl. Lab.

Price, B., and T. Kelly. 1976. Fishes of the Grand Traverse Bay region. Mich. Sea Grant Program, MICHU-SG-76-100.

Price, J. L. 1955. Operation of electrical barriers to sea lamprey migration in 1955 between East Davignon River and Pancake River inclusive. Append. D, pages 16-34 in Annu. Rep. to the Great Lakes Res. Comm., Sect. I.

Price, J. W. 1934. The embryology of the whitefish, Coreognus clupeaformis (Mitchill), Part I. Ohio J. Sci. 34:287-305.

Price, J. W. 1935. The embryology of the whitefish Coregonus clupeaformis (Mitchill). Part III. The second half of the incubation period. Ohio J. Sci. 35(1):40-53.

Price, J. W. 1940. Time-temperature relations in the incubation of the whitefish, Coregonus clupeaformis (Mitchill). J. Gen. Physiol. 23(4):449-469.

Priegel, G. R. 1960. Sturgeon studies. Page 19 in Research in Wisconsin 1959. Wis. Conserv. Dep., Madison.

Priegel, G. R. 1961. Sturgeon studies. Page 19 in Research in Wisconsin 1960, Wis. Conserv. Dep., Madison.

Priegel, G. R. 1962. Plentiful but unknown. Wis. Conserv. Bull. 27(3):13.

Priegel, G. R. 1963. Walleye nursery. Wis. Conserv. Bull. 28(2):6-7.

Priegel, G. R. 1966. Lake Puckaway walleye. Wis. Conserv. Dep., Res. Plann. Div. Res. Rep. No. 19.

Priegel, G. R. 1967a. The freshwater drum, its life history, ecology and management. Wis. Dep. Nat. Resour. Publ. No. 236.

Priegel, G. R. 1967b. Tattle-tale tags. Wis. Conserv. Bull. 32(4):6-7.

Priegel, G. R. 1968. Lake Winnebago cousins. Wis. Conserv. Bull. 33(2):24-25.

Pycha, R. L., and J. H. Selgeby. 1975. Status of major species of fish in U.S. waters of Lake Superior, 1974. Append. VII[A], Pages 69-73 in Minutes of the Lake Superior Comm. Annu. Meet., Great Lakes Fish. Comm.

Quick, R. F. 1971. The age and growth of brown trout (Salmo trutta) and sculpin (Cottus spp.) as it relates to eutrophication in the Jordan and Ausable Rivers. M.S. Thesis, Mich. State Univ.

Quirk, Lawler, and Matusky Engineers. 1974. 1973 Nine Mile Point aquatic ecology studies, QL & M Project Nos. 191-14,15,17. Submitted to Niagara Mohawk Power Corp. and Power Authority of the State of N.Y.

Radforth, I. 1944. Some considerations on the distribution of fishes in Ontario. Contrib. R. Ont. Mus. Zool. No. 25.

Rahrer, J. F. 1965. Age, growth, maturity, and fecundity of "humper" lake trout, Isle Royale, Lake Superior. Trans. Am. Fish. Soc. 94(1):75-83.

Rahrer, J. F. 1967. Growth of lake trout in Lake Superior before the maximum abundance of sea lampreys. Trans. Am. Fish. Soc. 96(3):268-277.

Rahrer, J. F. 1968. Movements of adult trout in Lake Superior. Trans. Am. Fish. Soc. 97(4):481-484.

Raney, E. C. 1940a. Comparison of the breeding habits of two subspecies of black-nosed dace, Rhinichthys atratulus (Hermann). Am. Midl. Nat. 23(2):394-403.

Raney, E. C. 1940b. The breeding behavior of the common shiner Notropis cornutus (Mitchill). Zoologica, New York Zool. Soc. 25(1):1-13.

Raney, E. C. 1943. Unusual spawning habitat for the common white sucker, Catostomus c. commersonii. Copeia (1943)4:256.

Raney, E. C. 1949. Nests under the water. Can. Nat. 11(3):71-78.

Raney, E. C. 1959. Some young fresh-water fishes of New York. New York State Conserv. 22-28.

Raney, E. C. 1969a. Minnows of New York. Part 1: Facts about some of our chubs and dace. Conservationist 23(5):22-29.

Raney, E. C. 1969b. Minnows of New York. Part 2: The shiners. Conservationist 23(6):21-29.

Raney, E. C. 1972. Remarks on heated discharges and fishes in southwestern Lake Michigan in the vicinity of the Zion Nuclear Power Station. 5 pp. (inserted between pp. 843 and 844) in Fourth session of the conference in the matter of pollution of Lake Michigan and its tributary basin in the states of Wisconsin, Illinois, Indiana, and Michigan, Vol. III (part 3 of 3 parts).

Raney, E. C., and E. A. Lachner. 1942. Studies of the summer food, growth, and movements of young yellow pike-perch, *Stizostedion vitreum vitreum*, in Oneida Lake, New York. J. Wildl. Manage. 6(1):1-16.

Raney, E. C., and E. A. Lachner. 1943. Age and growth of johnny darters, *Boleosoma nigrum olmstedi* (Storer) and *Boleosoma longimanum*. Am. Midl. Nat. 29(1):229-238.

Raney, E. C., and E. A. Lachner. 1946. Age, growth and habits of the hog sucker, *Hypentelium nigricans* (LeSueur), in New York. Am. Midl. Nat. 36(1):76-86.

Raney, E. C., and D. A. Webster. 1940. The food and growth of the common bullhead, *Ameirus nebulosus nebulosus* (LeSueur), in Cayuga Lake, New York. Trans. Am. Fish. Soc. 69(1939):205-209.

Raney, E. C., and D. A. Webster. 1942. The spring migration of the common white sucker, *Catostomus c. commersonnii* (Lacepede), in Skaneateles Lake inlet, New York. Copeia 1942(3):139-148.

Raphael, C. N., and E. Jaworski. 1979. Economic value of fish, wildlife, and recreation in Michigan's coastal wetlands. Coastal Zone Manage. J. 5(3):181-194.

Rathbun, R., and W. Wakeham. 1897. Report of the joint commission relative to the preservation of the fisheries in waters contiguous to Canada and the United States. House of Representatives, 54th Congress, 2nd session, Doc. No. 315.

Ravenel, W. deC. 1898. Report on the propagation and distribution of food-fishes. *In*: Rep. U.S. Comm. Fish Fish. (for the fiscal year ending June 30, 1897).

Rawson, M. R., and R. L. Scholl. 1978a. Reestablishment of sauger in western Lake Erie. Pages 261-265 *in* Selected coolwater fishes of North America, R. L. Kendall, ed. Am. Fish. Soc. Spec. Publ. 11.

Rawson, M. R., and R. L. Scholl. 1978b. Reestablishment of sauger, *Stizostedion canadense*, in western Lake Erie. Ohio Dep. Nat. Resour. Wildl. In-Service Note 387.

Reckahn, J. A. 1970. Ecology of young whitefish (*Coregonus clupeaformis*) in South Bay, Manitoulin Island, Lake Huron. Pages 437-460 *in* Biology of coregonid fishes, C. C. Lindsey and C. S. Woods, eds., Univ. Manitoba Press, Winnipeg.

Redband, F. 1912. The hatcheries--Caledonia station. *In*: The Annu. Rep. of the Fish Culturist, T. H. Bean, ed. Extract from the N.Y. Annu. Rep. of the Conserv. Comm., 1911.

Redband, F. 1913. The hatcheries--Caledonia Station. *In*: The Annu. Rep. of the Fish Culturist, T. H. Bean, ed. Extract from the N.Y. 2nd Annu. Rep. of the Conserv. Comm., 1912.

Redband, F. 1915. The hatcheries--Caledonia Station. In: New York 4th Annu. Rep. of the Conserv. Comm., 1914.

Reed, G. A. 1972. Wisconsin Michigan Power Company. Letter to T. A. Edsall, March 13, 1972, with attached "Weather and lakewater notes."

Reed, H. D., and A. H. Wright. 1909. The vertebrates of the Cayuga Lake Basin, New York. Proc. Am. Philos. Soc. 48:370-459.

Reed, R. J. 1957. The prolonged spawning of the rosyface shiner, Notropis rubellus (Agassiz), in northwestern Pennsylvania. Copeia 1957(3):250.

Reed, R. J. 1958. Early life history of two cyprinids, Notropis rubellis and Campostoma anomalum pullum. Copeia 1958(4):325-327.

Reed, R. J. 1971. Biology of the fallfish, Semotilus corporalis (Pisces, Cyprinidae). Trans. Am. Fish. Soc. 100:717-725.

Reeves, Cora D. 1907. The breeding habits of the rainbow darter (Etheostoma coeruleum Storer), a study in sexual selection. Biol. Bull. 14:35-59.

Regier, H. A. 1962. Smelt spawning areas near tip of Point Pelee, 1962. Ont. Dep. Lands For., unpubl. rep.

Regier, H. A. 1963. Survey of Lake Erie shores and tributaries for smelt spawning areas in April 1963. Ont. Dep. Lands For., file rep. unpubl.

Regier, H. A., and W. L. Hartman. 1973. Lake Erie's fish community: 150 years of cultural stresses. Science 180:1248-1255.

Regier, H. A., V. C. Applegate, R. A. Ryder, J. V. Manz, R. G. Ferguson, H. D. Van Meter, and D. R. Wolfert. 1969. The ecology and management of the walleye in western Lake Erie. Great Lakes Fish. Comm. Tech. Rep. No. 15.

Reid, D. J. 1978. The fish community within a cattail marsh bordering Inner Long Point Bay, Lake Erie. Contract Biologist, Ont. Min. Nat. Resour., Simcoe Admin. Dist.

Reighard, J. 1890. Development of the wall-eyed pike (Stizostedion vitreum). Bull. Mich. Fish Comm.

Reighard, J. 1900a. The breeding habits of the dog-fish, Amia calva. 1st Rep. Mich. Acad. Sci.:133-137.

Reighard, J. 1900b. The breeding habits of Amia. Sci. 11(268):251-252.

Reighard, J. 1902. Some further notes on the breeding habits of Amia. 3rd Rep. Mich. Acad. Sci.

Reighard, J. 1903. The natural history of *Amia calva* Linnaeus. Mark Anniversary Vol., Artic. IV:57-109.

Reighard, J. 1905. The breeding habits, development and propagation of the black bass. Mich. Fish Comm., Bull. No. 7.

Reighard, J. 1910. Methods of studying the habits of fishes with an account of the breeding habits of the horned dace. Bull. U.S. Bur. Fish. 28:1111-1136.

Reighard, J. 1913. Improvement of fishing through a knowledge of the breeding habits of fishes. Trans. Am. Fish. Soc. 43:97-103.

Reighard, J. 1915. An ecological reconnaissance of the fishes of Douglas Lake, Cheboygan County, Michigan, in midsummer. Bull. U.S. Bur. Fish. 33:215-249.

Reighard, J. 1920. The breeding behavior of the suckers and minnows. Biol. Bull. 28(1):1-32.

Reighard, J. 1943. The breeding habits of the river chub, *Nocomis micropogon* (Cope). Pap. Mich. Acad. Sci. Arts Lett. 28(1942):397-423.

Reighard, P. 1910. A plan for promoting the whitefish production of the Great Lakes. Bull. U.S. Bur. Fish. 28(part I):643-684.

Reigle, N. J., Jr. 1969a. Bottom trawl explorations in southern Lake Michigan, 1962-65. U.S. Bur. Commer. Fish. Circ. 301.

Reigle, N. J., Jr. 1969b. Bottom trawl explorations in Green Bay of Lake Michigan, 1963-65. U.S. Fish Wildl. Serv. Circ. 297.

Reigle, N. J., Jr. 1969c. Bottom trawl explorations in northern Lake Michigan, 1963-65. U.S. Fish Wildl. Serv. Circ. 318.

Reinert, R. E., and H. L. Bergman. 1974. Residues of DDT in lake trout (*Salvelinus namaycush*) and coho salmon (*Oncorhynchus kisutch*) from the Great Lakes. J. Fish. Res. Board Can. 31:191-199.

Reisman, H. M., and T. J. Cade. 1967. Physiological and behavioral aspects of reproduction in the brook stickleback, *Culaea inconstans*. Am. Midl. Nat. 77:257-295.

Reutter, J. M. 1979a. Fish impingement at the Davis-Besse Nuclear Power Station during 1978. Environ. Tech. Specifications, Sec. 3.1.2.a.6 Fish Impingement, Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 103.

Reutter, J. M. 1979b. Fish egg and larvae entrainment at the Davis-Besse Nuclear Power Station during 1978. Environ. Tech. Specifications, Sec. 3.1.2.a.5 Fish egg and larvae entrainment. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 104.

Reutter, J. M. 1979c. Ichthyoplankton studies from Lake Erie near the Davis-Besse Nuclear Power Station during 1978. Environ. Tech. Specifications, Sec. 3.1.2.a.4 Ichthyoplankton, Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 108.

Reutter, J. M., and C. E. Herdendorf. 1974. Response of fish and invertebrates to the heated discharge from the Davis-Besse reactor, Lake Erie, Ohio. Annu. perf. rep., Study I, Fed. Aid Proj. F-41-R-5, Environ. evaluation of a nuclear power plant on Lake Erie, period covered: June 1, 1973-May 31, 1974. Ohio State Univ., Center for Lake Erie Area Res.

Reutter, J. M., and C. E. Herdendorf. 1975. Response of fish and invertebrates to the heated discharge from the Davis-Besse reactor, Lake Erie, Ohio. Annu. perf. rep., Study I, Fed. Aid Proj. F-41-R-6, Environ. evaluation of a nuclear power plant on Lake Erie, period covered: June 1, 1974-May 31, 1975. Ohio State Univ., Center for Lake Erie Area Res.

Reutter, J. M., and C. E. Herdendorf. 1977. Pre-operational aquatic ecology monitoring program for the Davis-Besse Nuclear Power Station, Unit 1. Prog. rep. July 1-Dec. 31, 1976, in Davis-Besse Nuclear Power Station, Unit No. 1, Pre-operational environmental monitoring programs, semi-annu. rep., July 1, 1976-Dec. 31, 1976, Vol. VI.

Reutter, J. M., C. E. Herdendorf, and G. W. Sturm. 1978a. Impingement and entrainment studies at Acme Power Station, Toledo Edison Company, 316(B) Program, Task II. Ohio State Univ., Center for Lake Erie Res., CLEAR Tech. Rep. No. 78a.

Reutter, J. M., C. E. Herdendorf, and C. W. Sturm. 1978b. Impingement and entrainment studies at the Bay Shore Power Station, Toledo Edison Company, 316(B) Program, Task II. Ohio State Univ., Center for Lake Erie Res., CLEAR Tech. Rep. No. 78b.

Reynolds, J. B. 1970. An estimate of species, size, and sex composition of salmon in Hammond Bay, Lake Huron, October 1970. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., Admin. Rep.

Rhodes, R., D. A. Webb, and T. S. McComish. 1974. Cannabalism by the adult alewife (Alosa pseudoharengus) in southern Lake Michigan. Proc. Conf. Great Lakes Res. 17:593-595.

Richards, W. J. 1960. The life history, habits, and ecology of the white perch, Roccus americanus (Gmelin) in Cross Lake, New York. M.S. Thesis, State Univ. Coll. Forestry, Syracuse Univ.

Richardson, A. H. 1946. A report on the Ganaraska watershed. Ont. Dep. Plann. Dev.

Richardson, L. R. 1935. The fresh-water fishes of south-eastern Quebec. Ph.D. Thesis, McGill Univ.

Richardson, R. E. 1913a. Observations on the breeding habits of fishes at Havana, Illinois, 1910 and 1911. Bull. Ill. State Lab. Nat. Hist. Vol. 9, Artic. VIII:405-416.

Richardson, R. E. 1913b. Observations on the breeding of the European carp in the vicinity of Havanna, Illinois. Bull. Ill. State Lab. Nat. Hist. Vol. 9, Artic. VII:386-404.

Richey, D. 1976. Salmon surprise. Mich. Nat. Resour. 45(5):36.

Ricker, W. E. 1932. Studies of speckled trout (*Salvelinus fontinalis*) in Ontario. Univ. Toronto Stud., Publ. Ont. Fish. Res. Lab. No. 44:67-110.

Ricker, W. E. 1934. An ecological classification of certain Ontario streams. Univ. of Toronto Stud. Biol. Ser. No. 37, Publ. Ont. Fish. Res. Lab. No. 49.

Ricker, W. E. 1964. The need for habitat. Chapt. IV, pages 29-38 *in* Fish and Wildlife, a memorial to W. J. K. Harkness (J. R. Dymond, ed.), Longmans Canada Ltd., Toronto.

Riggs, C. D. 1955. Reproduction of the white bass. Invest. Indiana Lakes Streams 4(3):87-110.

Riggs, C. D. 1958. Selected references on the channel catfish (*Ictalurus punctatus*). U.S. Fish Wildl. Serv., Spec. Sci. Rep.-Fish. 240.

Robbins, W. H., and H. R. MacCrimmon. 1977. Vital statistics and migratory patterns of a potamodromus stock of smallmouth bass, *Micropterus dolemieui*. J. Fish. Res. Board Can. 34(1):142-147.

Robertson, O. H., and A. L. Chaney. 1953. Thyroid hyperplasia and tissue iodine content in spawning rainbow trout: a comparative study of Lake Michigan and California sea-run trout. Physiol. Zool. 26(4):328-340.

Robins, C. R., and E. E. Deubler, Jr. 1955. The life history and systematic status of the burbot, *Lota lota lacustris* (Walbaum), in the Susquehanna River system. N.Y. States Mus. Sci. Serv., Circ. No. 39.

Rochester Gas and Electric. 1972. Ginna Nuclear Power Plant, ecological studies of cooling water discharge. Part 1: Summary of ecological effects and changes resulting from introduction of thermal discharge.

Rochester Gas and Electric Corporation. 1977. Sterling Power Project Nuclear Unit No. 1, 1977 ichthyoplankton/small fish surveys, final rep., April 27, 1977 to Sept. 30, 1977.

Rodd, J. A. 1913. Fish breeding. Append. 19 *in* 45th annu. rep. of the Can. Dep. of Mar. and Fish., 1911-12. Fisheries. Sessional Paper No. 22.

Rodd, J. A. 1914. Fish breeding. Append. 18 *in* 46th annu. rep. of the Can. Dep. of Mar. and Fish., 1912-13. Fisheries. Sessional Paper No. 22.

Rodd, J. A. 1917. Fish breeding. Append. 16 *in* 49th annu. rep. of the Fish. Branch, 1915-16. Sessional Paper No. 39. Can. Dep. Naval Sci.

Rodd, J. A. 1918. Fish culture. Append. II *in* 50th annu. rep. of the Fish. Branch, 1916-17. Sessional Paper No. 39. Can. Dep. Naval Sci.

Rodd, J. A. 1919. Co-operation. Can. Fisherman 6(4):103-104.

Roelofs, E. W. 1958. Age and growth of whitefish, *Coregonus clupeaformis* (Mitchill), in Big Bay de Noc and northern Lake Michigan. Trans. Am. Fish. Soc. 87:190-199.

Romberg, G. P., and S. A. Spigarelli. 1973. Seasonal variation in species composition and abundance of fish at the Point Beach Nuclear Plant between March and November 1973. Pages 104-112 *in* Argonne Natl. Lab., Radiological and Environ. Res. Div. Annu. Rep., ANL-8060, Part III.

Romberg, G. P., S. A. Spigarelli, W. Prepejchal, and M. M. Thommes. 1974. Migratory behavior of fish tagged at nuclear power plant discharge into Lake Michigan. Proc. Conf. Great Lakes Res. 17:68-77.

Romberg, G. P., and M. M. Thommes. undated. Comparison of the movement and recapture of salmonid fishes tagged at two power plants. Pages 133-142 *in* Radiological and Environ. Res. Div. Annu. Rep., Ecology, January-December 1974, ANL-75-3, Part III, Argonne Natl. Lab.

Romberg, G. P., M. M. Thommes, and S. A. Spigarelli. undated. Origin of fin-clipped salmonids collected at two thermal discharges on Lake Michigan. Pages 143-149 *in* Radiological and Environ. Res. Div. Annu. Rep., Ecology, January-December 1974, ANL-75-3, Part III, Argonne Natl. Lab.

Rosa, S. 1979. Preliminary attempts in locating lake whitefish (*Coregonus clupeaformis*) spawning ground by winter egg collection, in areas of the upper St. Marys River. Ont. Min. Nat. Resour., unpubl. rep.

Roseborough, D. J. 1962. Smelt harvest by sport fishermen in Lake Erie. Ont. Fish Wildl. Rev. 1(4):8-12.

Ross, M. R. 1977. Function of creek chub (*Semotilus atromaculatus*) nest-building. Ohio J. Sci. 77(1):36-37.

Ross, M. R., and R. J. Reed. 1978. The reproductive behavior of the fallfish *Semotilus corporalis*. Copeia 1978(2):215-221.

Rothschild, B. J. 1966. Observations on the alewife (*Alosa pseudoharengus*) in Cayuga Lake. N.Y. Fish Game J. 13(2):188-195.

Rottiers, D. V. 1965. Some aspects of the life history of *Cottus cognatus* in Lake Michigan. M.S. Thesis, Univ. Mich.

Roussow, G. 1957. Observations in spawning periodicity, and ray sections as a measurement of growth. "Some considerations concerning sturgeon spawning periodicity." J. Fish. Res. Board Can. 14(4):553-572.

Royce, J. S. 1936. Collecting eggs from lake trout in New York lakes. N.Y. Fish Cult. 2(10):2-4.

Royce, W. F. 1951. Breeding habits of lake trout in New York. U.S. Fish Wildl. Serv. Fish. Bull. 59:59-76.

Rudolph, G. L., and R. L. Scholl. 1969. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-8, Job No. 3, July 1, 1969-June 30, 1970.

Rudolph, G. L., and R. L. Scholl. 1970a. Walleye sampling. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-9, Job No. 2, July 1, 1970-June 30, 1971.

Rudolph, G. L., and R. L. Scholl. 1970b. Walleye spawning area study in western Lake Erie. Ohio, Lake Erie fisheries Invest., Job Prog. Rep., Proj. No. F-35-R-9, Job No. 1, July 1, 1970-June 30, 1971.

Ruple, L. 1978. Lake trout shoal investigations in western Lake Ontario, Ont. Min. Nat. Resour. Lake Ontario assessment unit, draft manuscr.

Rybicki, R. W. 1973. A summary of the salmonid program (1969-1971). Pages 1-17 in Michigan's Great Lakes trout and salmon fishery (1969-72), Mich. Dep. Nat. Resour., Fish. Manage. Rep. No. 5.

Rybicki, R. W., and M. Keller. 1976. Progress report on major fish species in Lake Michigan. Append. IVA, pages 15-33 in Minutes (with append.) of Lake Michigan Comm. Meet., Great Lakes Fish. Comm.

Rybicki, R., and M. Keller. 1978. The lake trout resource in Michigan waters of Lake Michigan, 1970-1976. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1863.

Rybicki, R. W., M. Keller, and L. Moffit. 1975. 1974 progress reports on certain Lake Michigan fish stocks, harvest and regulations. Append. IV, pages 33-63, in Minutes (with append.) of Lake Michigan Comm. 1975 annu. meet., Great Lakes Fish. Comm.

Ryder, R. A. 1957. A study of the yellow pickerel population in Lake Superior and the Nipigon River System, 1956. Ont. Min. Nat. Resour. Fish and Wildl. Manage. Rep. No. 37.

Ryder, R. A. 1968. Dynamics and exploitation of mature walleyes, Stizostedion vitreum vitreum, in the Nipigon Bay Region of Lake Superior. J. Fish. Res. Board Can. 25(7):1347-1376.

Ryder, R. A. 1977. Effects of ambient light variations on behavior of yearling, sub adult and adult walleyes (Stizostedion vitreum vitreum). J. Fish. Res. Board Can. 34(10):1481-1490.

Salli, A. J. 1974. The distribution and behavior of young-of-year trout in the Brule River of northwestern Wisconsin. Ph.D. Thesis, Univ. Wis.

Sather, L. M., and C. W. Threinen. 1966. Surface water resources of Ashland County. Wis. Conserv. Dep., Madison.

Sauve, J., and J. Fowler. 1961. The spawning habits of the maskinonge. Montreal Anglers Hunters, Inc.

Savage, J. 1935. Smelts in the Canadian waters of Lake Huron. Copeia 1935(4):194.

Shaefer, W. F. 1975. A study of the growth patterns, food habits and seasonal depth distribution of the yellow perch, Perca flavescens in southwestern Lake Michigan. M.S. Thesis, Univ. Wis.-Milwaukee.

Schaefer, W. F. 1979. Population dynamics of rainbow smelt in Lake Superior. Subtitles: Characteristics of the spawning and post spawning die-off populations of smelt in western Lake Superior. Age, growth, and mortality of smelt in western Lake Superior. Ph.D. Thesis, Brigham Young University.

Schiemenz, F. 1925. Kuenstliche Befruchtung und Erbruetung von Stichlinserien. blaett. Aquar.-Terrarienk 36(13):340-342.

Schleen, L. P. 1974. Sea lamprey surveys, St. Marys River, 1973. Append. 5, pages 12-15, in Annual Report 1973 of the Sea Lamprey Control Centre, Sault Ste. Marie, Ont., to the Great Lakes Fish. Comm., of activities carried out under a Memorandum of Agreement during the period April 1, 1973 to March 31, 1974, by J. J. Tibbles, Annu. Rep. No. GRL/A-73.

Schleen, L. P. 1975. Individual stream treatment reports, Lake Superior, 1975. Append. 6, pages 16-30, in Annual Report 1975 of the Sea Lamprey Control Centre, Sault Ste. Marie, Ont., to the Great Lakes Fish. Comm., of activities carried out under a Memorandum of Agreement during the period April 1, 1974 to March 31, 1975, by J. J. Tibbles. Annu. Rep. No. GRL/A-75.

Schlueter, R. A. 1977. Reproduction of *Notropis spilopterus* and *Pimephales vigilax* in the lower White River, Pike County, Indiana. Proc. Indiana Acad. Sci. 87:430.

Schmidt, C. 1979. Eastern UP outdoor report. North Woods Call 24(10):2.

Schmidt, J. 1925. The breeding places of the eel. Annu. Rep. Smithson. Inst. for 1924: 279-316.

Schmidt, J. 1928. Life history of the eel. Science, N.S. 68(1750):xiv.

Schneberger, E. 1935. Notes regarding smelt in Green Bay. Wis. Conserv. Dep., unpubl. manuscr.

Schneberger, E. 1938. The Wolf River pike run. Wis. Conserv. Bull. 3(8):3-6.

Schneberger, E. 1939. Report on Wolf River survey. Wis. Conserv. Bull. 4(6):3-10.

Schneberger, E. 1940. 1940 Survey of Wolf River pike run. Wis. Conserv. Bull. 5(6):47-50.

Schneberger, E. 1972a. Smallmouth bass--its life history, ecology and management. Wis. Dep. Nat. Resour. Publ. 242.

Schneberger, E. 1972b. The white sucker--its life history, ecology and management. Wis. Dep. Nat. Resour. Publ. 245-72 (DO113).

Schneberger, E. 1972c. White crappie--life history, ecology and management. Wis. Dep. Nat. Resour. Publ. 244 (DI355).

Schneberger, E. 1973. Rock bass--life history, ecology and management. Wis. Dep. Nat. Resour.

Schneider, H., and A. D. Hasler. 1960. Laute und Lauterzeugung beim Susswassertrommler *Aplodinotus grunniens* Rafinesque (Sciaenidae, Pisces). V. GL. Physiol. 43:499-517.

Schneider, J. C. 1972. Dynamics of yellow perch in single-species lakes. Mich. Dep. Nat. Resour. Res. and Dev. Rep. No. 184, Inst. Fish. Res. Rep. No. 1791.

Schneider, J. C. 1977. History of the walleye fisheries of Saginaw Bay, Lake Huron. Mich. Dep. Nat. Resour., Fish Rep. No. 1850.

Schneider, J. C., and W. R. Crowe. 1977. A synopsis of walleye tagging experiments in Michigan, 1929-1965. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1844.

Schneider, J. C., and J. H. Leach. 1977. Walleye (*Stizostedion vitreum vitreum*) fluctuations in the Great Lakes and possible causes 1800-1975. J. Fish. Res. Board Can. 34(10):1878-1889.

Schneider, J. C., and J. H. Leach. 1979. Walleye stocks in the Great Lakes 1800-1975: fluctuations and possible causes. Great Lakes Fish. Comm. Tech. Rep. No. 31.

Scholl, R. L. 1964. Lake Erie fish population gill netting and shore seining survey. Ohio Dep. Nat. Resour., Div. Wildl., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-2, Job No. 4, Oct. 8, 1963-Oct. 16, 1963.

Scholl, R. L. 1965. Lake Erie fish population gill netting survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-3, Job No. 4, July 1, 1964-June 30, 1965.

Scholl, R. L. 1966. Lake Erie fish population gill netting survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-4, Job. No. 4, July 1, 1965-June 30, 1966.

Scholtz, A. T., J. C. Cooper, D. M. Madison, R. M. Horrall, A. D. Hasler, A. E. Dizon, and R. J. Poff. 1973. Olfactory imprinting in coho salmon: behavioral and electro-physiological evidence. Proc. Conf. Great Lakes Res. 16:143-153.

Schumacher, R. E., and S. Eddy. 1960. The appearance of pink salmon, Oncorhynchus gorbusha (Walbaum), in Lake Superior. Trans. Am. Fish. Soc. 89(4):371-372.

Schumacher, R. E., and J. G. Hale. 1962. Third generation pink salmon Oncorhynchus gorbuscha (Walbaum), in Lake Superior. Trans. Am Fish. Soc. 91:421-422.

Schuter, B. J., and J. F. Koonee. 1977. A dynamic model of the western Lake Erie walleye (Stizostedion vitreum vitreum) population. J. Fish. Res. Board Can. 34(10):1972-1982.

Scidmore, W. J. 1972. Comparison of egg deposition and rate of egg survival on improved and unimproved walleye spawning shoals. Minn., Job Prog. Rep., Dingell-Johnson Proj. No. F-26-R-3, April 1, 1971-March 31, 1972.

Scidmore, W. J. 1974. Walleye egg deposition and survival on an artificially improved spawning area. Minn., Job Proq. Rep., Dingell-Johnson Proj. No. F-36-R-5, Job. No. 106.1, April 1, 1973-March 31, 1974.

Scott, D. C. 1955. Activity patterns of perch, Perca flavescens, in Rondeau Bay of Lake Erie. Ecology 36(2):320-327.

Scott, T. G., H. C. Schultz, and P. H. Eschmeyer (eds.). 1978. Sport fishery and wildlife research 1975-1976. U.S. Fish Wildl. Serv.

Scott, W. B. 1950. The Lake Erie cisco (Leucichthys artedi) population. Ph.D. Thesis, Univ. Toronto.

Scott, W. B. 1951. Fluctuations in abundance of the Lake Erie cisco (Leucichthys artedi) population. R. Ont. Mus. Zool. Contrib. No. 32.

Scott, W. B. 1967. Freshwater fishes of eastern Canada. Second ed., Univ. Toronto Press.

Scott, W. B., and W. J. Christe. 1963. The invasion of the lower Great Lakes by the white perch, Roccus americanus (Gmelin). J. Fish. Res. Board Can. 20(5):1189-1195.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184.

Scott, W. B., and S. H. Smith. 1962. The occurrence of the longjaw cisco, Leucichthys alpenae, in Lake Erie. J. Fish. Res. Board Can. 19(6):1013-1023.

Scott, W. E. 1936. Fishing in Lake Superior. Minn. Conserv.:1-24.

Seal W. P. 1892. Observations on the aquaria of the U.S. Fish Commission at Central Station, Washington, D.C. U.S. Fish. Comm. Bull. 10(1890):1-12.

Sea Lamprey Control Centre. 1979a. List of sea lamprey streams. Can. Fish. Mar. Serv., Sault Ste. Marie, Ont., unpubl. data.

Sea Lamprey Control Centre. 1979b. Data--records of lamprey treatments and surveys. Can. Fish. Mar. Serv., unpubl.

Selden, C. P., and H. Van Meter. 1960. Lake Erie walleye--again on the upswing? Ohio Conserv. Bull. 24(1):5-7.

Selgeby, J. H. 1978. The decline of lake herring (Coregonus artedii) in Lake Superior with analyses of rainbow smelt (Osmerus mordax)--herring interrelations and of the Wisconsin herring fishery. U.S. Fish. Wildl. Serv., Great Lakes Fish. Lab., Res. Completion Rep.

Selgeby, J. H. 1979. Biology of the sculpins of Lake Superior. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., draft manuscr.

Selgeby, J. H., W. R. McCallum, and D. V. Swedberg. 1978. Predation by rainbow smelt (Osmerus mordax) on lake herring (Coregonus artedii) in western Lake Superior. J. Fish. Res. Board Can. 35(11):1457-1463.

Seward, R. 1967. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-5, Job No. 3, July 1, 1966-June 30, 1967.

Seward, R. 1968. Lake Erie fish population trawling survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-6, Job., No. 3, July 1, 1967-June 30, 1968.

Shea, N. W. 1972. Establishment and maintenance of Pacific salmon populations in the Pennsylvania waters of Lake Erie. Penn. Fish Comm. Segment Rep. A.F.S. 5-1, April 1, 1970-June 30, 1972.

Shealy, M. H., Jr. 1971. Nesting bass observed with underwater television. N.Y. Food Life Sci. 4(4):18-20.

Sheldon, S. 1977. The age and growth of walleye (*Stizostedion vitreum vitreum*) in the New York waters of Lake Erie. M.S. Thesis, State Univ. N.Y.-Buffalo.

Sheri, A. N., and G. Power. 1968. Reproduction of white perch, *Roccus americanus*, in the Bay of Quinte, Lake Ontario. J. Fish. Res. Board Can. 25(10):2225-2231.

Sheri, A. N., and G. Power. 1969. Fecundity of the yellow perch, *Perca flavescens* Mitchill, in the Bay of Quinte, Lake Ontario. Can. J. Zool. 47(1):55-58.

Shetter, D. S. 1937. Contributions to the natural history of some game fishes of Michigan, particularly the brook trout, *Salvelinus f. fontinalis* (Mitchill), as determined by tagging experiments. Ph.D. Thesis, Univ. Mich.

Shetter, D. S. 1938a. A two-way fish trap for use in studying stream-fish migrations. Trans. Am. Wildl. Nat. Resour. Conf. 3: 331-338.

Shetter, D. S. 1938b. Rainbow are the travelers of trout species. Mich. Conserv. 8(7):6, 7, and 11.

Shetter, D. S. 1949. A brief history of the sea lamprey problem in Michigan waters. Trans. Am. Fish. Soc. 76(1946):160-176.

Shetter, D. S. 1950. Rainbow and river mouths. Mich. Conserv. 19(1):31-34.

Shira, A. F. 1917. Notes on the rearing, growth, and food of the channel catfish (*Ictalurus punctatus*). Trans. Am. Fish. Soc. 46(2):77-88.

Shuter, B. J., J. A. MacLean, F. E. J. Fry, and H. A. Regier. 1980. Stochastic simulation of temperature effects on first-year survival of smallmouth bass. Trans. Am. Fish. Soc. 109(1):1-34.

Sibley, C. K. 1922. Notes on the adult fishes of Lake George, and their feeding habits. Pages 64-68 *in* A Biological Survey of Lake George, N.Y., by J. G. Needman, C. Juday, E. Moore, C. K. Sibley, and J. W. Titcomb. N.Y. Conserv. Comm.

Siefert, R. E. 1968. Reproductive behavior, incubation and mortality of eggs, and postlarval food selection in the white crappie. Trans. Am. Fish. Soc. 97(3):252-259.

Siefert, R. E. 1969. Biology of the white crappie in Lewis and Clark Lake. U.S. Bur. Sport Fish. Wildl. Tech. Pap. No. 22.

Siefert, R. E. 1972. First food of larval yellow perch, white sucker, bluegill, emerald shiner, and rainbow smelt. Trans. Am. Fish. Soc. 101(2):219-225.

Skiff, J. V., D. H. Weeks, and U. B. Stone. 1950. Lake Ontario. N.Y. State Conserv. 4(4):7-10.

Skille, J. 1968. A study of the rock bass, Ambloplites rupestris (Rafinesque). Univ. Wis.-Stevens Point.

Slastenenko, E. P. 1956. The growth of yellow pike-perch Stizostedion vitreum in Three Mile Lake, Ontario. Can. Fish. Cult. 19:8.

Slastenenko, E. P. 1958. The freshwater fishes of Canada. Toronto.

Smallwood, W. M., and M. L. Smallwood. 1931. The development of the carp Cyprinus carpio. I. The larval life of the carp with special reference to the development of the intestinal tract. J. Morphol. Physiol. 52(1):217-231.

Smallwood, W. M., and P. H. Struthers. 1928. III. Carp control studies in Oneida Lake. Pages 67-83 in A biological survey of the Oswego River System. Suppl. to 17th Annu. Rep. (1927). N.Y. Conserv. Dep., Albany.

Smedley, H. H. 1938. Trout of Michigan. Printed by author, Muskegon, Mich.

Smiley, C. W. 1882. Changes in the fisheries of the Great Lakes during the decade 1870-1880. Trans. Am. Fish. Soc. 11:28-37.

Smiley, C. W. 1886. Some results of carp culture in the United States. Rep. U.S. Fish. Comm. 12:657-890.

Smith, A. J., J. H. Howell, and G. W. Piavis. 1968. Comparative embryology of five species of lampreys of the upper Great Lakes. Copeia 1968(3):461-469.

Smith, B. G. 1922. Notes on the nesting habits of Cottus. Pap. Mich. Acad. Sci. Arts Lett. 2:221-224.

Smith, B. R. 1971. Sea lampreys in the Great Lakes of North America. Pages 207-247 in The Biology of Lampreys, Vol. 1, M. W. Hardisty, and I. C. Potter, eds., Academic Press, N.Y.

Smith, B. R., and R. A. Braem. 1976. Sea lamprey control in the United States. Append. C, pages 34-49 in Great Lakes Fish. Comm. Annu. Rep. for 1974.

Smith, B. R., and O. R. Elliott. 1953. Movement of parasitic-phase sea lampreys in Lakes Huron and Michigan. Trans. Am. Fish. Soc. 82:123-128.

Smith, B. R., and A. L. McLain. 1962. Estimation of the brook and sea lamprey ammocete populations of three streams. Great Lakes Fish. Comm. Tech. Rep. 4.

Smith, B. R., and J. J. Tibbles. 1980. Sea lamprey (Petromyzon marinus) in Lakes Huron, Michigan, and Superior: History of invasion and control, 1936-78. Can. J. Fish. Aquat. Sci. 37(11):1780-1801.

Smith, B. R., J. J. Tibbles, and B. G. H. Johnson. 1974. Control of the sea lamprey (Petromyzon marinus) in Lake Superior, 1953-70. Great Lakes Fish. Comm. Tech. Rep. No. 26.

Smith, H. M. 1892. Report on an investigation of the fisheries of Lake Ontario. Bull. U.S. Fish Comm. 10:177-215.

Smith, H. M. 1913. National Geographic Society Magazine 24(10):1140-1146.

Smith, H. M. and L. G. Harron. 1904. Breeding habits of the yellow catfish. Bull. U.S. Fish. Comm. 22:149-154.

Smith, H. M., and M-M. Snell. 1891. Review of the fisheries of the Great Lakes in 1885. U.S. Fish. Comm. Rep. 15:1-333.

Smith, J. B. 1968. Former lake trout spawning grounds in Lake Huron. Ont. Dep. Lands For., Res. Branch Sect. Rep. (Fish.) No. 68.

Smith, L. 1937. Observations on natural versus artificial propagation of commercial species of fish in the Great Lakes region. Trans. Am. Fish. Soc. 66(1936):56-62.

Smith, L. L., D. R. Franklin, and R. Kramer. 1958. Determination of factors influencing year-class strength in northern pike and largemouth bass. Minn., Dingell-Johnson Proj. No. F12R, Jobs II and III.

Smith, L. L., Jr., and W. M. Koenst. 1975. Temperature effects on eggs and fry of percoid fishes. U.S. Environ. Prot. Agency, EPA-660/3-75-017.

Smith, L. L., and R. H. Kramer. 1964. The spottail shiner in lower Red Lake, Minnesota. Trans. Am. Fish. Soc. 93(1):35-45.

Smith, L. L., Jr., L. W. Krefting, and R. L. Butler. 1952. Movements of marked walleyes, Stizostedion vitreum vitreum (Mitchill), in the fishery of the Red Lakes, Minnesota. Trans. Am. Fish. Soc. 81:179-196.

Smith, L. L., Jr., and N. L. Moe. 1944. Minnesota fish facts. Minn. Dep. Conserv., Conserv. Bull. No. 7.

Smith, L. L., Jr., and J. B. Moyle. 1944. A biological survey and fishery management plan for the streams of the Lake Superior North Shore watershed. Minn. Dep. Conserv., Div. Game Fish. Tech. Bull. No. 1.

Smith, L. L., and R. L. Pycha. 1960. First-year growth of the walleye Stizostedion vitreum vitreum and associated factors in the Red Lakes, Minnesota. Limnol. Oceanogr. 5(3):281-290.

Smith, M. W., and J. W. Saunders. 1955. The American eel in certain fresh waters of the Maritime Provinces of Canada. J. Fish. Res. Board Can. 12(2):238-269.

Smith, O. H., and J. Van Oosten. 1939. Tagging experiments with lake trout, whitefish and other species of fish from Lake Michigan. Trans. Am. Fish. Soc. 69:63-84.

Smith, O. R. 1935. The breeding habits of the stone roller minnow, Campostoma anomalum Rafinesque. Trans. Am. Fish. Soc. 65:148-151.

Smith, P. W. 1963. A study of seasonal distribution of fishes in the Kaskaskia River Ditch, a highly modified stream in eastern Illinois. Copeia 1963(2):251-259.

Smith, R. 1909. Whitefish and trout in Lake Michigan. Pages 25-29 in Rep. Ill. State Fish Comm. Oct. 1, 1906, to Sept. 30, 1908.

Smith, R. P. 1978. Regional report, upper peninsula. Mich. Out-of-Doors 32(12):31.

Smith, S. H. 1954. Life history of the lake herring, Leucichthys artedii of Green Bay, Lake Michigan. Ph.D. Thesis, Univ. Mich.

Smith, S. H. 1956. Life history of lake herring of Green Bay, Lake Michigan. U.S. Fish Wildl. Serv., Fish. Bull. 57:87-138.

Smith, S. H. 1964. Status of deepwater cisco population of Lake Michigan. Trans. Am. Fish. Soc. 93(2):155-163.

Smith, S. H. 1968. The alewife. Limnos 1(2):12-20.

Smith, S. H. 1969. Important food fishes of inland waters. U.S. Fish and Wildl. Serv., Great Lakes Fish. Lab. admin. rep.

Smith, S. H. 1972. Factors of ecologic succession in oligotrophic fish communities of the Laurentian Great Lakes. J. Fish. Res. Board Can. 29(6):717-730.

Smith, S. H. 1978a. Blue pike. Endangered species, Great Lakes Region, U.S. Fish Wildl. Serv., Suppl. March 9.

Smith, S. H. 1978b. Longjaw cisco. Endangered species, Great Lakes Region, U.S. Fish Wildl. Serv., Suppl. March 9.

Smith, S. H. 1978c. The salmon may make it. Nat. Hist. 87(7):80-87.

Smith, S. H., H. J. Buettner, and R. Hile. 1961. Fishery statistical districts of the Great Lakes. Great Lakes Fish. Comm. Tech. Rep. No. 2.

Snow, H., A. Ensign, and J. Klingbiel. 1960. The bluegill--its life history, ecology and management. Wis. Conserv. Dep. Publ. 230.

Snyder, F. L. 1978. Icthyoplankton studies in the Maumee and Sandusky River estuaries of Lake Erie. Ohio State Univ., Center for Lake Erie Area Res., CLEAR Tech. Rep. No. 92.

Spangler, G. R., and A. H. Berst. 1978. Questions and answers on splake. Ont. Fish Wildl. Rev. 17(2):3-8.

Spangler, G. R., N. R. Payne, and G. K. Winterton. 1977. Percids in the Canadian waters of Lake Huron. J. Fish. Res. Board Can. 34(10):1839-1841.

Speare, E. P. 1958. The ecology, age and growth rate of the central johnny darter, *Etheostoma nigrum nigrum* (Rafinesque), Augusta Creek, Michigan. Ph.D. Thesis, Mich. State Univ.

Speare, E. P. 1965. Fecundity and egg survival of the central johnny darter (*Etheostoma nigrum nigrum*) in southern Michigan. Copeia 1965(4):308-314.

Speirs, J. M. 1954. Annual report to the Great Lakes Research Committee 1954.

Speirs, J. M. 1955. Biological programme in 1955 on streams tributary to Lake Superior between Pigeon River and Big Pic River inclusive. Append. B, pages 9-15 *in* Annu. rep. to the Great Lakes Res. Comm., 1955, Sect. I.

Spigarelli, S. A. Tagging data, 1972-1974.

Spigarelli, S. A., G. P. Romberg, M. M. Thommes, and W. Prepejchal. Thermal plume residence and temperature exposure of salmonid fishes. Pages 9-13 *in* Radiol. Environ. Res. Div. Annu. Rep., Ecol., January-December 1976. ANL-76-88, Part III, Argonne Natl. Lab.

Spigarelli, S. A., and D. W. Smith. 1976. Growth of salmonid fishes from heated and unheated areas of Lake Michigan--measured by RNA-DNA ratios. Pages 100-105 *in* Thermal Ecology II, G. W. Esch and R. W. McFarlane, eds., Tech. Inf. Center, Energy Res. Dev. Admin. Symp. Ser. 40.

Spigarelli, S. A., and M. M. Thommes. 1976. Sport fishing at a thermal discharge into Lake Michigan. J. Great Lakes. Res. 2(1):99-110.

Spoor, W. A. 1938. Age and growth of the sucker, *Catostomas commersoni* (Lacepede) in Muskellunge Lake, Vilas County, Wisconsin. Trans. Wis. Acad. Sci. Arts Lett. 31:475-505.

Spotila, J. R., K. M. Terpi, R. R. Koons, and R. L. Bonati. 1979. Temperature requirements of fishes from eastern Lake Erie and the upper Niagara River: a review of the literature. Environ. Biol. Fish. 4(3):281-307.

Stauffer, T. M. 1961. Distribution of sea lamprey ammocoetes in Lake Michigan tributaries of the upper peninsula of Michigan 1955-1959. Mich. Dep. Conserv., Inst. Fish. Res., Misc. Publ. No. 14.

Stauffer, T. M. 1962. Duration of larval life of sea lampreys in Carp Lake River, Michigan. Trans. Am. Fish. Soc. 91(4):422-423.

Stauffer, T. M. 1969a. Population dynamics of anadromous rainbow trout in a Lake Superior tributary. Mich. Dep. Nat. Resour., Job Completion Rep., Proj. No. F-31-R-2, Job No. 4, July 1, 1967-June 30, 1968.

Stauffer, T. M. 1969b. Population dynamics and life history of anadromous rainbow trout in Lake Superior tributaries. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-3, Job No. 4, July 1, 1968-June 30, 1969.

Stauffer, T. M. 1970. Fecundity of coho salmon from Lake Michigan. Mich. Dep. Nat. Resour., Res. Dev. Rep. No. 212.

Stauffer, T. M. 1971a. Salmon eggs as food for stream salmonids and sculpins. Mich. Dep. Nat. Resour., Res. Dev. Rep. No. 233.

Stauffer, T. M. 1971b. Great Lakes fish biology and population ecology. Reproduction by steelhead (rainbow) trout transferred to a spawning area. Mich. Dep. Nat. Resour., Job Final Rep., Dingell-Johnson Proj. No. F-31-R-4, Job No. 2, July 1, 1969-June 30, 1970.

Stauffer, T. M. 1971c. Population dynamics and life history of anadromous rainbow trout in Lake Superior tributaries. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-4, Job. No. 4, July 1, 1969-June 30, 1970.

Stauffer, T. M. 1971d. Production of juvenile rainbow trout and coho salmon in five Lake Superior tributaries. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-5, Study No. I, Job No. I-1, July 1, 1970-June 30, 1971.

Stauffer, T. M. 1972a. Age, growth, and downstream migration of juvenile rainbow trout in a Lake Michigan tributary. Trans. Am. Fish. Soc. 101(1):18-28.

Stauffer, T. M. 1972b. Estimate number of coho salmon spawners. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-6, Study No. II, Job No. II-5, July 1, 1971-June 30, 1972.

Stauffer, T. M. 1972c. Determine distinguishing characteristics of hatchery-reared and feral adult coho salmon. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-6, Study No. II, Job No. II-6, July 1, 1971-June 30, 1972.

Stauffer, T. M. 1973a. Estimate populations of juvenile salmonids in Lake Superior tributaries, assess growth and biomass of juvenile salmonids in Lake Superior tributaries, determine mortality of juvenile rainbow trout. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-7, Study No. II, Job No. II-1,2,3, July 1, 1972-June 30, 1973.

Stauffer, T. M. 1973b. Estimate number of coho salmon spawners. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-7, Study No. II, Job No. II-5, July 1, 1972-June 30, 1973.

Stauffer, T. M. 1973c. Fecundity of coho salmon from Lakes Michigan and Superior. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1806.

Stauffer, T. M. 1974a. Estimate populations of juvenile salmonids in Lake Superior tributaries and biomass of juvenile salmonids in Lake Superior tributaries, determine mortality of juvenile rainbow trout. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-8, Study No. II, Job No., II-1,2,3, July 1, 1973-June 30, 1974.

Stauffer, T. M. 1974b. Estimate number of coho salmon spawners. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-8, Study No. II, Job No. II-5, July 1, 1973-June 30, 1974.

Stauffer, T. M. 1974c. Determine morphological characteristics of immature lake trout of various races. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-8, Study No. V, Job No. V-3, July 1, 1973-June 30, 1974.

Stauffer, T. M. 1975a. Population characteristics and summer-to-autumn survival of juvenile rainbow trout and coho salmon in two Lake Superior tributaries, 1969-1972. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1825.

Stauffer, T. M. 1975b. Coho salmon and steelhead trout in Lake Superior tributaries. Mich. Dep. Nat. Resour., Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-1 (Group 4), Study No. II, July 1, 1974-June 30, 1975.

Stauffer, T. M. 1976a. Fecundity of coho salmon (*Oncorhynchus kisutch*) from the Great Lakes and a comparison with ocean salmon. J. Fish. Res. Board Can. 33(5):1150-1155.

Stauffer, T. M. 1976b. Anadromous brook trout in Lake Superior. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-2 (Group 4), Study No. XI, July 1, 1975-June 30, 1976.

Stauffer, T. M. 1977. Numbers of juvenile salmonids produced in five Lake Superior tributaries and the effect of juvenile coho salmon on their numbers and growth 1967-1974. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1846.

Stauffer, T. M. 1978a. Behavior of age-0 and age-1 lake trout under laboratory conditions. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1857.

Stauffer, T. M. 1978b. Develop methods of capture and assess early survival of young lake trout in Lakes Superior and Michigan. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-4 (Group 4), Study No. 413, Oct. 1, 1977-Sept. 30, 1978.

Stauffer, T. M. 1979a. Two-year cycles of abundance of age-0 rainbow trout in Lake Superior tributaries. Trans. Am. Fish. Soc. 108:542-547.

Stauffer, T. M. 1979b. Develop methods of capture and assess early survival of young lake trout in Lakes Superior and Michigan. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-5 (Group 4), Study No. 413, Oct. 1, 1978-Sept. 30, 1979.

Stauffer, T. M., and M. H. Hansen. 1958. Distribution of sea lamprey ammocoetes in Michigan tributaries of Lake Superior 1955-1957. Mich. Dep. Conserv., Inst. Fish. Res., Misc. Publ. No. 11.

Stauffer, T. M., and J. W. Peck. 1977. Develop methods of capture, and assess early survival of young lake trout in Lakes Superior and Michigan. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-3 (Group 4), Study No. XIII, July 1, 1976-Sept. 30, 1977.

Stauffer, T. M., J. W. Peck, and W. C. Wagner. 1976. Develop methods of capture, and assess early survival of young lake trout in Lakes Superior and Michigan. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-2 (Group 4), Study No. XIII, July 1, 1975-June 30, 1976.

Stauffer, T. M., and W. C. Wagner. 1975. Survival of lake trout from egg to swim-up fry in Lake Michigan. Mich. Dep. Nat. Resour., Annu. Prog. Rep., Dingell-Johnson Proj. No. F-35-R-1 (Group 4), Study No. VI, July 1, 1974-June 30, 1975.

Stauffer, T. M., and W. C. Wagner. 1976. Survival of lake trout from egg to swim-up in Lake Michigan. Mich. Dep. Nat. Resour., Study Final Rep., Dingell-Johnson Proj. No. F-35-R-2 (Group 4), Study No. VI, July 1, 1975-June 30, 1976.

Sterling, E. 1876. Propagation of white fish. Trans. Am. Fish Cult. Assoc. 5:13-15.

Sterling, E. 1883. On the impropriety of depositing whitefish minnows off the harbor of Cleveland, Ohio--fishing for saugers. Bull. U.S. Fish. Comm. 3:302-303.

Stevenson, F. 1966. A study of bluegill, Lepomis macrochirus, reproduction in two Ohio farm ponds. M.S. Thesis, Ohio State Univ.

Stewart, N. H. 1926. Development, growth, and food habits of the white sucker, *Catostomus commersoni* (LeSueur). Bull. U.S. Bur. Fish 42:147-184.

St. Lawrence-Eastern Ontario Commission. 1978. Coastal resources: the area's fishery. St. Lawrence-Eastern Ont. Comm. Tech. Rep. Ser. No. 4.

Stockwell, G. A. 1875a. Fishes and fishing of the Great Lakes--the whitefish. For. Stream 5(19):193.

Stockwell, G. A. 1875b. Fishes and fishing of the Great Lakes--the siskowit and mackinaw trout. For. Stream 5(20):307.

Stockwell, G. A. 1876. Fishes and fishing of the Great Lakes--bass, perch, herring, and suckers. For. Stream 5(22):343.

Stone, F. L. 1948. A study of the taxonomy of the blue and the yellow pike perches (Stizostedion) of Lake Erie and Lake Ontario. Ph.D. Thesis, Univ. Rochester (N.Y.).

Stone, L. 1900. The spawning habits of lake sturgeon. Trans. Am. Fish. Soc. 29:118-128.

Stone, L. 1901. Sturgeon hatching in the Lake Champlain Basin. Trans. Am. Fish. Soc. 30:137-143.

Stone, U. B. 1938. Growth, habits and fecundity of the ciscoes of Irondequoit Bay, New York. Trans. Am. Fish. Soc. 67(1937):234-245.

Stone, U. B. 1940. Studies on the biology of the satinfin minnows, *Notropis analostanus* and *Notropis spilopterus*. Cornell Univ. Abstr. Theses:288-290.

Stone, U. B. 1944. A study of the deep-water cisco fishery of Lake Ontario with particular reference to the bloater *Leucichthys hoyi*. Trans. Am. Fish. Soc. 74:230-249.

Stone, U. B., and W. L. Hartman. 1957. Finger Lakes rainbows--tagging studies and future management. N.Y. State Conserv. 11(5):6-8.

Stone, U. B., D. G. Pasko, and R. M. Roecker. 1951. A study of smallmouth bass--Lake Ontario-St. Lawrence River. N.Y. Conserv. Dep., Res. Ser. Div. Fish Game, No. 2.

Stone, U. B., D. G. Pasko, and R. M. Roecker. 1954. A study of Lake Ontario--St. Lawrence River; smallmouth bass. N.Y. Fish Game J. 1(1):1-26.

Storck, T. W., D. W. Dufford, and K. T. Clement. 1978. The distribution of limnetic fish larvae in a flood control reservoir in central Illinois. Trans. Am. Fish. Soc. 107(3):419-24.

Storr, J. F. 1977. Fish tag report summary 1972-1976, Niagara Mohawk Power Corp.

Stoudt, J. H. 1939. A study of the migration of the wall-eyed pike (Stizostedion vitreum) in the waters of the Chippewa National Forest, Minnesota. Trans. Am. Fish. Soc. 68:163-169.

Stoudt, J. H., and S. Eddy. 1939. Walleye pike tagging study, 1937-1938, Chippewa National Forest. Trans. North Am. Wildl. Conf. 4:305-310.

Stranahan, J. J. 1898. The whitefish. Rep. U.S. Comm. Fish Fish. 1897:119-131.

Strang, J. J. 1855. Some remarks on the natural history of Beaver Islands, Michigan. Ninth Annual Report of miscellaneous correspondence on natural history in: Annu. Rep. Board Regents Smithson. Instit. 9:282-288.

Struthers, P. H. 1929. Carp control studies in the Erie Canal. Pages 208-219 in A biological survey of the Erie-Niagara System. Suppl. 18th Annu. Rep. 1928, N.Y. Conserv. Dep.

Struthers, P. H. 1931. Carp control studies in the Seneca, Canadaigua, and Keuka Lake basins. Pages 217-229 in A biological survey of the St. Lawrence watershed (including the Grass, St. Regis, Salmon, Chateaugay systems and the St. Lawrence between Ogdensburg and the International Boundary). Suppl. 20th Annu. Rep. 1930, N.Y. Conserv. Dep.

Suns, K., and G. A. Rees. 1978. Organochlorine contaminant residues in young-of-the-year spottail shiners from Lakes Ontario, Erie, and St. Clair. J. Great Lakes Res. 4(2):230-233.

Surber, E. W., and D. D. Friddle. 1946. Recent toxicity of suspension and oil formulations on native fishes in Back Creek, West Virginia. Trans. Am. Fish. Soc. 76:315-321.

Surber, T. 1920. A preliminary catalogue of the fishes and fish-like vertebrates of Minnesota. Append. to Bienn. Rep. State Game Fish Comm. Minn. for period ending June 30, 1920.

Surber, T. 1924. Propagation and distribution of fish. Bienn. Rep. of State Game Fish Comm. Minn. for period ending June 30, 1924.

Surber, T. 1940. Propagation of minnows. Minn. Dep. Conserv., Div. Fish Game.

Surface, H. A. 1897. The lampreys of central New York. Bull. U.S. Fish Comm. 17:209-215.

Swanson, B. L. 1976. Wisconsin--depletion of Gull Island-Michigan Island native lake trout spawning populations. Pages 52-56 in Append. VIII Minutes of Lake Superior Comm., Great Lakes Fish. Comm.

Swanson, B. L., and D. V. Swedberg. 1980. Decline and recovery of the Lake Superior Gull Island Reef lake trout (Salvelinus namaycush) population and the role of sea lamprey (Petromyzon marinus) predation. Can. J. Fish. Aquat. Sci. 37(11):2074-2080.

Swanson Environmental, Inc. 1976. Cooling water intake monitoring program March 1975-February 1976, Wisconsin Power and Light Company, Edgewater Generating Station, Sheboygan, Wisconsin.

Swanson Environmental, Inc. 1979. 316(a) type-II demonstration project, Wisconsin Power and Light Company, Edgewater Unit 5, Sheboygan Wisconsin. Part I--Biological, chemical and physical data.

Swedberg, D. V., and J. H. Selgeby. 1979. Biology, structure and yield of Chequamegon Bay walleye populations. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab, Admin. Rep.

Swedberg, D. V., and C. H. Walburg. 1970. Spawning and early life history of the freshwater drum in Lewis and Clark Lake, Missouri River. Trans. Am. Fish. Soc. 99(3):560-570.

Swee, U. B. 1965. Studies on the reproductive biology of the carp, Cyprinus carpio Linnaeus in Lake St. Lawrence. M.S. Thesis, Univ. Guelph.

Swee, U. B., and H. R. McCrimmon. 1966. Reproductive biology of the carp, Cyprinus carpio L., in Lake St. Lawrence, Ontario. Trans. Am. Fish. Soc. 95(4):372-380.

Sweeney, R. A. 1978. Aquatic disposal field investigations--Ashtabula River disposal site, Ohio. Append. A.: Planktonic communities, benthic assemblages, and fishery. U.S. Army Corps Eng., Dredged Mater. Res. Program Tech. Rep. D-77-42.

Swift, C. H. III. 1979. Preferred stream discharges for salmon spawning and rearing in Washington. U.S. Geol. Surv., Open-File Rep. 77-422.

Symons, G. E., and R. W. Simpson. 1939. Report on fish destruction in the Niagara River in 1937. Trans. Am. Fish. Soc. (1938) 68:246-255.

Sztramko, L., and G. C. Teleki. 1977. Annual variations in the fecundity of yellow perch from Long Point Bay, Lake Erie. Trans. Am. Fish. Soc. 106(6):578-582.

Taber, C. A. 1969. The distribution and identification of larval fishes in the Buncombe Creek arm of Lake Texoma with observations on spawning habits and relative abundance. Ph.D. Thesis, Univ. Okla.

Taft, C. E. 1975. History of Cladophora in the Great Lakes, summary of workshop presentation. Pages 9-15 in Cladophora in the Great Lakes, H. Shear and D. E. Konasewich, eds. Int. Joint Comm., Advis. Board.

Tait, H. D. 1973. Great Lakes Fishery Laboratory. Pages 86-120 in Progress in sport fishery research 1971. U.S. Bur. Sport Fish. Wildl., Resour. Publ. 121.

Tanner, H. A. 1964. Fish section. Mich. Dep. Conserv. 22nd Bienn. Rep. 1963-1964.

Taube, C. M. 1969. Competition among coho salmon, steelhead trout, and brown trout. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-3, Job No. 5, July 1, 1968-June 30, 1969.

Taube, C. M. 1971a. Competition among coho salmon, steelhead and brown trout. Mich. Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. F-31-R-4, Job No. 5, July 1, 1969-June 30, 1970.

Taube, C. M. 1971b. Competition among coho salmon, rainbow trout and brown trout. Mich. Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-5, Study No. I, Job No. I-2, July 1, 1970-June 30, 1971.

Taube, C. M. 1972. Population estimates and rate of growth of salmonids in Platte River. Mich. Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-6, Study No. I, Job No. I-1,2, July 1, 1971-June 30, 1972.

Taube, C. M. 1973. Salmonid population estimates; determine growth of trout. Mich. Dep. Nat. Resour. Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-7, Study No. I, Job No. I-1,2, July 1, 1972-June 30, 1973.

Taube, C. M. 1974a. A descriptive and historical account of the Platte River, its surrounding area, and its salmonid fishes. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1809.

Taube, C. M. 1974b. Transfer releases of coho salmon and trout into an upper part of Platte River, and observations on salmon spawning. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1815.

Taube, C. M. 1974c. Stability of residence among brown trout and rainbow trout in experimental sections of Platte River. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1817.

Taube, C. M. 1975. Abundance, growth, biomass, and interrelationship of trout and coho salmon in the Platte River. Mich. Dep. Nat. Resour., Fish. Res. Rep. No. 1830.

Taudvin, J. W. 1910. Untitled. Ont. Game Fish Dep., 3rd Annu. Rep., 1909.

Taylor, J. N. 1978. Behavioral components of reproductive success in male sunfishes of the genus Lepomis. Ph.D. Thesis, Univ. Mich.

Taylor, W. R. 1955. A revision of the genus Noturus Rafinesque with a contribution to the classification of the North American catfishes. Ph.D. Thesis, Univ. Mich.

Taylor, W. R. 1969. A revision of the catfish genus Noturus Rafinesque with an analysis of higher groups in the Ictaluridae. U.S. Natl. Mus. Bull. No. 282.

Teater, R. W. 1976. Letter to Colonel Bernard C. Hughes, U.S. Army Corps. Eng., Buffalo District, Feb. 5, 1976. Page A-30 in Append. A., Letters of Coordination in Final Environmental Impact Statement, Operation and Maintenance, Vermilion Harbor, Erie County, Ohio, Prep. by U.S. Army Eng., Buffalo Dist.

Teleki, G. C. 1975a. An evaluation of the aquatic ecosystem (fisheries) of Long Point Bay, Lake Erie, relative to shoreline industrialization. Ont. Min. Nat. Resour., Rep. No. 3.

Teleki, G. C. 1975b. The influence of shoreline industrialization on the fish populations in Long Point Bay, Lake Erie. Ont. Min. Nat. Res., Rep. No. 4, 1974.

Teleki, G. C. 1976. The incidence and effect of once-through cooling on young-of-the-year fishes at Long Point Bay, Lake Erie: a preliminary assessment. Pages 387-393 in Thermal ecology II., G. W. Esch and R. W. McFarlane, eds. U.S. Tech. Info. Center, Energy Res. Dev. Admin., Oak Ridge, Tenn.

Teleki, G. C., N. G. MacLean, and L. K. Sztramko. 1977. The influence of shoreline industrialization on the fish populations in Long Point Bay, Lake Erie. Ont. Min. Nat. Resour., Nanticoke Project, Rep. No. 5, 1975.

Tester, A. L. 1930. Spawning habits of the small-mouthed black bass in Ontario waters. Trans. Am. Fish. Soc. 60:53-61.

Texas Instruments Incorporated. 1975a. Report of fish and macrozooplankton studies on the St. Clair River in the vicinity of the proposed Belle River Power Plant. Prep. for Detroit Edison Co.

Texas Instruments Incorporated. 1975b. 1974-1975 Annual Report, Bailey Nuclear-1 site, encompassing April 1974-Feb. 1975. Prep. for Northern Ind. Publ. Serv. Co.

Texas Instruments Incorporated. 1976a. 1975-1976 Annual Report, Bailly Nuclear-1 site, encompassing March 1975-Feb. 1976. Prep. for Northern Ind. Publ. Serv. Co.

Texas Instruments Incorporated. 1976b. Summer 1976 quarterly report, Bailly Nuclear-1 site, encompassing June-August 1976 (Sept. 1976). Prep. for Northern Ind. Publ. Serv. Co.

Texas Instruments Incorporated. 1976c. 316(b) demonstration, Bailly Station, Units 7 and 8.

Texas Instruments Incorporated. 1976d. U.S. Corps of Engineers Dunkirk Harbor fisheries project, reports of May, June, and July survey. U.S. Army Corps Eng., Buffalo, N.Y.

Texas Instruments Incorporated. 1977a. Final report, 1975-76 near field study at Pomfret and Sheridan sites, Lake Erie Generating Station. Prep. for Niagara Mohawk Power Corp.

Texas Instruments Incorporated. 1977b. 1976-1977 Annual Report, Bailly Nuclear-1 site, encompassing March 1976-March 1977. Prep. for Northern Ind. Publ. Serv. Co.

Texas Instruments Incorporated. 1977c. Spring 1977 quarterly report, Bailly Nuclear-1 site, April-June 1977. Prep. for Northern Ind. Publ. Serv. Co.

Texas Instruments Incorporated. 1977d. 316(a) demonstration, Dunkirk Steam Station on Lake Erie near Dunkirk, New York.

Texas Instruments Incorporated. 1977e. Intake considerations, Dunkirk Steam Station Units 1-4, Niagara Mohawk Power Corp.

Texas Instruments Incorporated. 1978. Great Lakes basin and connecting water bodies. Chapter 6 in Part 1, Biological effects of once-through cooling, Vol. 5. Submitted to U.S. Environ. Prot. Agency by the Utility Water Act Group.

Texas Instruments Incorporated. 1979a. 1978-1979 Annual Report, Bailly Nuclear-1 site, encompassing April 1978-March 1979. Prep. for Northern Ind. Publ. Serv. Co.

Texas Instruments Incorporated. 1979b. A report of the aquatic ecology and water chemistry of the Rockport, National City, and Quanicasse Power Plant sites.

Texas Instruments Incorporated. 1979c. The aquatic ecology and potential effects of power plant operation on the aquatic biota at the Rockport site. In The aquatic ecology and potential effects of power plant operation on the aquatic biota at the Rockport, National City, and Quanicasse sites. Prep. for Consumers Power Co.

Texas Instruments Incorporated. 1979d. The aquatic ecology and potential effects of power plant operation on the aquatic biota at the National City site. In The aquatic ecology and potential effects of power plant operation on the aquatic biota at the Rockport, National City, and Quanicasse sites. Prep. for Consumers Power Co.

Texas Instruments Incorporated. 1979e. The aquatic ecology and potential effects of power plant operation on the aquatic biota at the Quanicasse site. In The aquatic ecology and potential effects of power plant operation on the aquatic biota at the Rockport, National City, and Quanicasse sites. Prep. for Consumers Power Co.

Thede, J. M. [1970]. The rainbow trout spring spawning run, Sturgeon River--1970. Ont. Min. Nat. Resour.

Thomas, M. L. H. 1961a. The distribution of sea lamprey ammocoetes in the lake of eight rivers draining into the Canadian waters of Lake Superior. Fish. Res. Board Can., Manuscr. Rep. Ser. (Biol.) No. 710.

Thomas, M. L. H. 1961b. Ammocoete biology. Fish. Res. Board Can. Prog. Rep. Biol. Stn. and Tech. Unit, London, Ont., No. 2:14-17.

Thomas, M. L. H. 1962. Observations on the ecology of ammocoetes of Petromyzon marinus L. and Entosphenus lamottei LeSueur in the Great Lakes watershed. M.S. Thesis, Univ. Toronto.

Thomas, M. L. H. 1966. Benthos of four Lake Superior bays. Can. Field Nat. 80(4):200-212.

Thomasson, R. D. 1963. Some observations on the American smelt, Osmerus mordax (Mit.), in the central basin of Lake Erie. M.S. Thesis, Univ. Toronto.

Threinen, C. W. 1958. Life history, ecology, and management of the alewife. Wis. Conserv. Dep. Publ. 223.

Threinen, C. W., and A. Oehmke. 1950. The northern invades the musky's domain. Wis. Conserv. Bull. 15(9):10-12.

Threinen, C. W., C. Wistrom, B. Apelgren, H. Snow. 1966. The northern pike, life history, ecology and management. Wis. Conserv. Dep. Publ. No. 235.

Thurston, L. 1973. Comparison of the contribution made by naturally and artificially reared walleye fry at the Moon River during 1973. Ont. Min. Nat. Resour., unpubl. rep.

Thurston, L. 1975. The strength of the 1975 walleye year class at the Moon River Parry Sound District. Ont. Min. Nat. Resour., unpubl. rep.

Tibbles, J. J. 1959. Preparations for lamprey control in Lake Huron. Prog. Rep. Biol. Stn. and Tech. Unit, London, Ont. (Fish. Res. Board Can.) (1):22-27.

Tibbles, J. J. 1975. Annual report to the Department of the Environment and the Great Lakes Fishery Commission for 1975-1976. Annu. Rep. No. GRL/A-75.

Tibbles, J. J. 1978. Stream treatment reports, Lake Ontario, Canada. Append. 10, pages 46-58, in Annu. rep. 1977 of the Sea Lamprey Control Centre, Sault Ste. Marie, Ont., to the Great Lakes Fish. Comm. of activities carried under a Memorandum of Agreement during the period April 1, 1977 to March 31, 1978. Annu. Rep. No. GRL/A-77.

Tibbles, J. J. 1979. Annual report 1978 of the Sea Lamprey Control Centre, Sault Ste. Marie, Ontario, to the Great Lakes Fishery Commission of activities carried out under a Memorandum of Agreement during the period April 1, 1978 to March 31, 1979. Annu. Rep. No. GRL/A-78.

Tibbles, J. J., S. M. Dustin, and B. G. H. Johnson. 1976a. Canadian report on sea lamprey control. Great Lakes Fish. Comm. Interim Meet., Agenda Item IV-C,2.

Tibbles, J. J., S. M. Dustin, and B. G. H. Johnson. 1976b. Sea lamprey control in Canada. Pages 50-55 in Great Lakes Fish. Comm. Annu. Rep. for 1974.

Tiessen, H. 1967. Notes of interview conducted by H. A. Regier.

Tilton, D. L., R. H. Kadlec, and B. R. Schwegler. 1978. Phase II: The ecology and values of Michigan's coastal wetlands. In Coastal wetlands value study in Michigan, Phase I and II, Mich. Coastal Manage. Program.

Titcomb, J. W. 1920. Some fish-cultural notes. Trans. Am. Fish. Soc. 50:200-211.

Titcomb, J. W. 1922. Fish cultural observations. Pages 69-78 in A biological survey of Lake George, N.Y., by J. G. Needham, C. Juday, E. Moore, C. K. Sibley, and J. W. Titcomb, N.Y. Conserv. Comm.

Todd, T. N. 1978. Revised status of Great Lakes coregonines. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., mimeo.

Todd, T. N., and S. H. Smith. unpubl. data. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., Ann Arbor, MI.

Tody, W. H. 1969. Mich. Dep. of Conserv. 24th Biennial Rep., 1967-1968. Fish Div.

Tody, W. H. 1970. Mich. Dep. Nat. Resour. 25th Bienn. Rep. 1969-1970. Fish Div.

Tody, W. H., and H. A. Tanner. 1966. Coho salmon for the Great Lakes. Mich. Dep. Nat. Resour., Fish. Manage., Rep. No. 1.

Toman, F. 1955. White perch. N.Y. State Conserv. 10(1):28.

Tomkins, F. T. 1951. The life history of and reproduction of Georgian Bay lake trout, with some notes on the commercial fishery. M.S. Thesis, Univ. Toronto.

Tomlin, W. D. 1887a. Migration of Lake Superior fish. Trans. Am. Fish. Soc. 16:60-62.

Tomlin, W. D. 1887b. Results of planting whitefish fry in Lake Superior. Bull. U.S. Fish. Comm. 6:411.

Toner, G. C. 1937. Preliminary studies of the fishes of eastern Ontario. Bull. Eastern Ont. Fish Game Prot. Assoc., Suppl. 2.

Toner, G. C. 1940. The smelt in upper St. Lawrence waters. Can. Field Nat. 54:59.

Toner, G. C. 1943. Ecological and geographical distribution of fishes in eastern Ontario. M.S. Thesis, Univ. Toronto.

Torblaa, R. L., and R. W. Westman. 1980. Ecological impacts of lampricide treatments on sea lamprey (*Petromyzon marinus*) ammocoetes and metamorphosed individuals. Can. J. Fish. Aquat. Sci. 37(11):1835-1850.

Toth, L. 1978. Resource partitioning between two species of darters, *Etheostoma caeruleum* and *Etheostoma flabellare*. M.S. Thesis, Northern Ill. Univ.

Townes, M. A. undated. Port Severn pickerel spawning ground investigation. Ont. Min. Nat. Resour. unpubl. rep.

Townes, M. A. 1976. Navigation and propagation. Ont. Fish Wildl. Rev. 15(3-4):6-8.

Trautman, M. B. 1935. The attempted introduction of Pacific salmon in Lake Erie waters. Mich. Inst. Fish. Res., Rep. No. 298.

Trautman, M. 1948. A natural hybrid catfish, *Schilbeodes miurus* X *Schilbeodes mollis*. Copeia 1948(3):166-174.

Trautman, M. B. 1950. A hostile force invading Lake Erie. Ohio Conserv. Bull. 14(1):4-6.

Trautman, M. B. 1957. The fishes of Ohio. Ohio State Univ. Press, Columbus, Ohio.

Trautman, M. B. 1975. The fishes of the Sandusky River system, Ohio. Pages 233-241 *in* Proc. Sandusky River Basin Symp. May 2-3, 1975. Int. Joint Comm., Int. Ref. Group on Great Lakes Pollut. from Land Use Activities.

Trautman, M. B. 1977. The Ohio country from 1750 to 1977--a naturalist view. Published by Ohio State Univ., Ohio Biol. Surv. from 1750-1977, Biol. Notes No. 10.

Trautman, M. B., and D. K. Gartman. 1974. Re-evaluation of the effects of man-made modifications on Gordon Creek between 1887 and 1973 and especially as regards its fish fauna. Ohio J. Sci. 74(3):162-173.

Traver, J. R. 1929. The habits of the black-nosed dace, Rhinichthys atronasus (Mit.). J. Elisha Mitchell Sci. Soc. 45(1):101-129.

True, F. W. 1887. The fisheries of the Great Lakes. Part XVII. Pages 631-673 in Section II of the U.S. Comm. Fish Fish. Industries of the United States, by G. Brown Goode and Associates.

Tucker, T. R. 1968. Aspects of the life history of the walleye, Stizostedion vitreum vitreum in Hoover Reservoir, Ohio. M.S. Thesis, Ohio State Univ.

Turner, C. L. 1920a. Distribution, food and fish associates of young perch in the Bass Island region of Lake Erie. Ohio J. Sci. 20(5):137-152.

Turner, C. L. 1920b. Food of young large-mouth black bass in some Ohio waters. Trans. Am. Fish. Soc. 50:372-380.

Turner, C. L. 1922. Notes on the food habits of young of Cottus ictalops (Miller's thumb). Ohio J. Sci. 12(3):95-96.

Turner, C. L. 1927. Biological survey of Fox, Wisconsin and Flambeau Rivers, Wisconsin, with special reference to pollution. Pages 242-276 in Stream Pollution in Wisconsin, Special Report, a joint report of the Conserv. Comm. and State Board of Health of Wisconsin concerning activities in the control of stream pollution, from July 1, 1925 to December 31, 1926.

Turner, G. E., and H. R. MacCrimmon. 1970. Reproduction and growth of smallmouth bass, Micropterus dolomieui, in a Precambrian lake. J. Fish. Res. Board Can. 27:395-400.

Underhill, A. H. 1941. Estimation of a breeding population of chubsuckers. Trans. North. Am. Wildl. Conf. 5:251-256.

United Press International. 1979. Expect a 'bonanza fishing weekend!' The Ann Arbor News, April 19.

U.S. Army Corps of Engineers, Buffalo District. undated (a). Final environmental impact statement, permit application by Niagara Mohawk Power Corps. proposed Lake Erie generating Station.

U.S. Army Corps of Engineers, Buffalo District. undated (b). Final environmental impact statement, permit application by United States Steel Corps., proposed Lake Front Steel Mill, Conneaut, Ohio.

U.S. Army Corps of Engineers, Buffalo District. 1973. Draft environmental statement, Lake City Station--Unit 1.

U.S. Army Corps of Engineers, Buffalo District. 1974. Draft environmental statement. Diked disposal site no. 2, Conneaut Harbor, Ashtabula Co., Ohio.

U.S. Army Corps of Engineers, Buffalo District. 1976. Final environmental impact statement operation and maintenance. Vermilion Harbor, Erie County, Ohio.

U.S. Army Corps of Engineers, Detroit District. 1978. Survey study for Great Lakes St. Lawrence Seaway navigation season extension. Prelim. draft environ. statement.

U.S. Army Corps of Engineers, Detroit District. 1979. Survey study for Great Lakes and St. Lawrence Seaway navigation season extension--draft environmental statement. In Survey study for Great Lakes and St. Lawrence Seaway navigation season extension--draft main rep. and environ. statement.

U.S. Army Corps of Engineers, Detroit District. 1976a. Draft environmental statement, Ottawa River Harbor, Michigan and Ohio.

U.S. Army Corps of Engineers, Detroit District. 1976b. Monitoring and evaluation of physical impacts of Toledo diked disposal site in Maumee Bay.

U.S. Atomic Energy Commission. 1972a. Final environmental statement--related to the operation of the Enrico Fermi Atomic Power Plant--Unit 2--Detroit Edison Co. Docket No. 50-341.

U.S. Atomic Energy Commission. 1972b. Final environmental statement related to operation of Point Beach Nuclear Plant, Units 1 and 2. Wis. Electric Power Co. and Wis.-Mich. Power Co. Docket Nos. 50-266 and 50-301.

U.S. Atomic Energy Commission. 1972c. Draft environmental statement by the U.S. Atomic Energy Commission Directorate of Licensing for the Zion Nuclear Power Station, Units 1 and 2 of the Commonwealth Edison Co. Docket Nos. 50-295 and 50-304.

U.S. Atomic Energy Commission. 1972d. Final environmental statement related to operation of Palisades Nuclear Generating Plant. Consumers Power Co. Docket No. 50-255.

U.S. Atomic Energy Commission. 1972e. Final environmental statement related to operation of the Kewaunee Nuclear Power Plant of Wis. Publ. Serv. Corp. Docket No. 50-305.

U.S. Atomic Energy Commission. 1972f. Draft environmental impact statement for Bailly Generating Station Nuclear-1 of Northern Ind. Publ. Serv. Co. Docket No. 50-367.

U.S. Atomic Energy Commission. 1972g. Draft environmental statement on the environmental considerations related to the completion and proposed operation of the James A. Fitzpatrick Nuclear Power Plant by the Power Authority of the State of New York. Docket No. 50-333.

U.S. Atomic Energy Commission. 1973. Final environmental statement related to construction of Davis-Besse Nuclear Power Station. Docket No. 50-346.

U.S. Bureau of Commercial Fisheries. 1965. Report on commercial fisheries resources of the Lake Michigan basin.

U.S. Bureau of Commercial Fisheries. 1966. Report on commercial fisheries resources of the Lake Erie basin.

U.S. Bureau of Commercial Fisheries. 1968. Status of lake trout in the Michigan inshore waters of Lake Superior, 1967. Append. III In Minutes of Lake Superior Comm. Annu. Meeting, Great Lakes Fish. Comm.

U.S. Bureau of Commercial Fisheries. 1969a. Report on commercial fisheries resources of the Lake Ontario basin.

U.S. Bureau of Commercial Fisheries. 1969b. Report on commercial fisheries resources of the Lake Superior basin.

U.S. Commission of Fish and Fisheries. 1882. Report of work at the United States Hatchery, Northville, Michigan, 1881-82. Rep. U.S. Comm. Fish and Fish., 1881, 9:1052-1053.

U.S. Commission of Fish and Fisheries. 1885. Report of the Commissioner for 1883, Part XI.

U.S. Commission of Fish and Fisheries. 1900. A manual of fish-culture, based on the methods of the United States Commission of Fish and Fisheries. U.S. Comm. Fish Fish. 23:1-247.

U.S. Department of the Interior. U.S. Fish and Wildlife Service. 1966. Fish and wildlife as related to water quality of the Lake Michigan basin. A special report on fish and wildlife resources.

U.S. Department of the Interior. U.S. Fish and Wildlife Service. 1967. Fish and wildlife as related to water quality of the Lake Erie basin. A special report on fish and wildlife resources.

U.S. Department of the Interior. U.S. Fish and Wildlife Service. 1969a. Fish and wildlife as related to water quality of the Lake Huron basin. A special report on fish and wildlife resources.

U.S. Department of the Interior. U.S. Fish and Wildlife Service. 1969b. Fish and wildlife as related to water quality of the Lake Ontario basin. A special report on fish and wildlife resources.

U.S. Department of the Interior. U.S. Fish and Wildlife Service. 1970. Fish and wildlife as related to water quality of the Lake Superior basin. A special report on fish and wildlife resources.

U.S. Fish and Wildlife Service. 1945. Fishery resources of the United States. Doc. No. 51, 79th Congr., 1st sess.

U.S. Fish and Wildlife Service. 1977. Great Lakes connecting channels follow-up study. Great Lakes Reg., Twin Cities, Minn.

U.S. Fish and Wildlife Service. 1978. Survey of fish stocks in U.S. waters of Lake Ontario during IFYGL, 1972. unpubl. data.

U.S. Fish and Wildlife Service. 1979a. Numbers of sea lampreys caught at barriers in tributaries of the south shore of Lake Superior, 1950-1975. Chart from Marquette Biol. Stn.

U.S. Fish and Wildlife Service. 1979b. Numbers of sea lampreys caught at barriers in tributaries of Lake Michigan, 1945-1966. Chart from Marquette Biol. Stn.

U.S. Fish and Wildlife Service. 1979c. Weir collections--unpubl. data. Marquette Biol. Stn.

U.S. Fish and Wildlife Service. 1979d. Draft fish and wildlife report to accompany the Corps of Engineers survey report, Great Lakes--St. Lawrence Seaway navigation season extension.

U.S. Nuclear Regulatory Commission. 1975a. Final environmental statement related to construction of Davis-Besse Nuclear Power Station Units 2 and 3. Docket Nos. 50-500 and 50-501.

U.S. Nuclear Regulatory Commission. 1975b. Final environmental statement related to operation of Davis-Besse Nuclear Power Station Unit 1. Docket No. 50-346.

Van Cleave, H. J., and H. C. Markus. 1929. Studies on the life history of the blunt-nosed minnow. Am. Nat. 63(689):530-539.

Van Meter, H. D. 1960. The yellow perch of Lake Erie. Ohio Conserv. Bull. :22-23.

Van Meter, H. D. 1973. Unharvested fishes in the U.S. commercial fishery of western Lake Erie in 1969. U.S. Natl. Mar. Fish. Serv. Spec. Sci. Rep.-Fish. 670.

Van Meter, H. D., and M. B. Trautman. 1970. An annotated list of the fishes of Lake Erie and its tributary waters exclusive of the Detroit River. Ohio J. Sci. 70(2):65-78.

Van Oosten, J. 1926. Report of a preliminary survey of conditions in the Sandusky Bay region, Ohio, with special references to the destructiveness of commercial nets. U.S. Dep. Commer., Bur. Fish.

Van Oosten, J. 1927a. Condensed report of spawning seasons at various Great Lake points--Michigan waters. U.S. Fish Wildl. Serv., Great Lakes Fish. Lab., unpubl. rep.

Van Oosten, J. 1927b. Life histories of the coregoninae. Pages 662-667 *In* Progress in biological inquiries 1926, Elmer Higgins. Rep. U.S. Comm. Fish. for 1927.

Van Oosten, J. 1929. Life history of the lake herring (*Leucichthys artedi* Le Sueur) of Lake Huron as revealed by its scales, with a critique of the scale method. U.S. Bur. Fish. Bull. 44:265-428.

Van Oosten, J. 1930. The disappearance of the Lake Erie cisco--a preliminary report. Trans. Am. Fish. Soc. 60:204-214.

Van Oosten, J. 1937a. The dispersal of smelt, Osmerus mordax (Mitchill), in the Great Lakes region. Trans. Am. Fish. Soc. 66(1936):160-171.

Van Oosten, J. 1937b. The age, growth and sex ratio of the Lake Superior longjaw (Leucichthys zenithicus). Pap. Mich. Acad. Sci. Arts Lett. 22(1936):691-711.

Van Oosten, J. 1937c. A preliminary study of the whitefish. U.S. Bur. Fish., Great Lakes Fish. Invest., Unpubl. Admin. Rep. 198-218.

Van Oosten, J. 1938a. The age and growth of the Lake Erie sheepshead, Aplodinotus grunniens Rafinesque. Pap. Mich. Acad. Sci. Arts Lett. 23(1937):651-668.

Van Oosten, J. 1938b. Field notes, trip to upper Michigan with Mr. Fred Westerman, Nov. 21-Dec. 8, 1937. Unpubl.

Van Oosten, J. 1939. The age, growth, and sexual maturity, and sex ratio of the common whitefish, Coregonus clupeaformis (Mitchill), of Lake Huron. Pap. Mich. Acad. Sci. Arts Lett. 24(1938):195-221.

Van Oosten, J. 1942. The age and growth of the Lake Erie white bass, Lepibema chrysops (Rafinesque). Pap. Mich. Acad. Sci. Arts Lett. 27(1941):307-334.

Van Oosten, J. 1944a. Lake trout. U.S. Fish Wildl. Serv. Fish. Leaf. 15.

Van Oosten, J. 1944b. The great smelt mystery. Mich. Conserv. 13(6):8.

Van Oosten, J. 1946. The pikes. U.S. Fish Wildl. Serv. Fish. Leaf. 166.

Van Oosten, J. 1947. Mortality of smelt (Osmerus mordax) in Lakes Huron and Michigan during the fall and winter of 1942-1943. Trans. Am. Fish. Soc. 74:310-337.

Van Oosten, J. 1953. The smelt (Osmerus mordax). Mich. Dep. Conserv., Fish Div., Pamphlet 8.

Van Oosten, J. 1956. The lake sturgeon. Pages 9-10 in Our endangered wildlife. Natl. Wildl. Fed., Washington, D.C.

Van Oosten, J. 1960. The true pikes. U.S. Fish Wildl. Serv. Fish. Leaf. 496.

Van Oosten, J., and H. J. Deason. 1957. History of Red Lakes fishery, 1917-38, with observations on population status. U.S. Fish Wildl. Serv., Spec. Sci. Rep.-Fish. 229.

Van Oosten, J., and P. H. Eschmeyer. 1956. Biology of young lake trout (Salvelinus namaycush) in Lake Michigan. U.S. Fish Wildl. Serv. Res. Rep. 42.

Van Oosten, J., and R. Hile. 1949. Age and growth of the lake whitefish, Coregonus clupeaformis (Mitchill), in Lake Erie. Trans. Am. Fish. Soc. 77(1947):178-249.

Van Vooren, A. 1976a. Characteristics of walleye spawning stocks. Ohio Dep. Nat. Resour., Perf. Rep., Dingell-Johnson Proj. No. F-35-R-14, Study IV, July 1, 1975-June 30, 1976.

Van Vooren, A. 1976b. Characteristics of walleye spawning stocks. Ohio Dep. Nat. Resour., Perf. Rep., Dingell-Johnson Proj. No. F-35-R-15, Study IV, July 1, 1976-June 30, 1977.

Van Vooren, A. 1978. Characteristics of walleye spawning stocks. Ohio Dep. Nat. Resour., Final Rep., Dingell-Johnson Proj. No. F-35-R, Study IV, July 1, 1975-June 30, 1978.

Van Vooren, A., and D. H. Davies. 1974. Survey of fish species in Ohio waters of Lake Erie. Ohio Dep. Nat. Resour., Perf. Rep., Dingell-Johnson Proj. No. F-35-R-12, Study No. II, July 1, 1973-June 30, 1974.

Van Vooren, A., D. H. Davies, and G. A. Emond. 1975. Survey of fish species in Ohio waters of Lake Erie. Ohio Dep. Nat. Resour., Perf. Rep., Dingell-Johnson Proj. No. F-35-R-13, Study II, July 1, 1970-June 30, 1975.

Van Vooren, A., D. H. Davies, and G. A. Emond. 1977. Survey of fish species in Ohio waters of Lake Erie. Ohio Dep. Nat. Resour., Perf. Rep., Dingell-Johnson Proj. No. F-35-R-15, Study No. II, July 1, 1976-June 30, 1977.

Van Vooren, A., D. H. Davies, and G. A. Emond. 1978. Survey of fish species in Ohio waters of Lake Erie. Ohio Dep. Nat. Resour., Perf. Rep., Dingell-Johnson Proj. No. F-35-R-16, Study II, July 1, 1977-June 30, 1978.

Vokes, J. 1912. Untitled. Pages 38-39 in Ont. Game Fish Dep. 5th Annu. Rep.

Voris, J. H. 1899. Material for study of the variation of Pimephales notatus (Rafinesque), in Turkey Lake and in Shoe and Tippecanoe Lakes. Proc. Ind. Acad. Sci. 1898, 233-239.

Wagner, G. 1911. The cisco of Green Lake, Wisconsin. Bull. Wis. Nat. Hist. Soc. 9:73-77.

Wagner, W. C. 1961. Fish collections in the Ontonagon River, Ontonagon, Houghton and Gogebic Counties, 1957 and 1959. Mich. Dep. Conserv. Inst. Fish. Res. Rep. No. 1615.

Wagner, W. C. 1968. The sport fishery on Little Bay de Noc, 1965. Mich. Dep. Conserv. Res. Dev. Rep. No. 146 (Inst. Fish. Res. Rep. No. 1748).

Wagner W. C. 1971. Studies on alewives in shoal waters of the Great Lakes. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-4, Job No. 1, July 1, 1969-June 30, 1970.

Wagner W. C. 1972. Utilization of alewives by inshore piscivorous fishes in Lake Michigan. Trans. Am. Fish. Soc. 101(1):55-63.

Wagner W. C. 1974a. Assess population trends of pink salmon in Lake Superior tributaries. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-8, Study No. II, Job No. II-8, July 1, 1973-June 30, 1974.

Wagner W. C. 1974b. Assess survival of eggs and young lake trout in Lakes Michigan and Superior. Mich. Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-31-R-8, Study No. V, Job No. V-2, July 1, 1973-June 30, 1974.

Wagner W. C. 1976a. Pink salmon in Michigan tributaries of the Great Lakes, 1975. Append. IX in Minutes of Lake Superior Comm. Meet., Great Lakes Fish. Comm.

Wagner W. C. 1976b. Coho salmon and steelhead trout in Lake Superior tributaries. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-2 (Group 4), Study No. II, July 1, 1975-June 30, 1976.

Wagner W. C. 1977. Pink salmon in the Great Lakes. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-3 (Group 4), Study No. III, July 1, 1976-Sept. 30, 1977.

Wagner W. C. 1978a. Pink salmon in Great Lakes. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-4 (Group 4), Study No. 403, Oct. 1, 1977-Sept. 30, 1978.

Wagner W. C. 1978b. Assess survival of planted lake trout eggs in the upper Great Lakes. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-4 (Group 4), Study No. 415, Oct. 1, 1977-Sept. 30, 1978.

Wagner W. C. 1978c. A three-year-old pink salmon from Lake Superior. Mich. Dep. Nat. Resour., Fish. Div., Fish. Res. Rep. No. 1861.

Wagner W. C. 1979. Pink salmon in Great Lakes. Mich. Dep. Nat. Resour., Study Perf. Rep., Dingell-Johnson Proj. No. F-35-R-5 (Group 4), Study No. 403, Oct. 1, 1978-Sept. 30, 1979.

Wagner W. C., and T. M. Stauffer. 1962. Sea lamprey larvae in lentic environments. Trans. Am. Fish. Soc. 91(4):384-87.

Wagner W. C., and T. M. Stauffer. 1975. Occurrence of pink salmon in Michigan, 1963-1973. Mich. Dep. Nat. Resour., Fish. Div. Tech. Rep. No. 75-3.

Wagner W. C., and T. M. Stauffer. 1978. Survival of rainbow trout stocked in a Lake Superior tributary 1971-1973. Mich. Dep. Nat. Resour., Fish. Div. Res. Rep. No. 1859.

Wagner W. C., and T. M. Stauffer. 1980. Three-year-old pink salmon in Lake Superior tributaries. Trans. Am. Fish. Soc. 109(4):458-460.

Wagner W. C., T. M. Stauffer, and M. J. Hansen. 1972. Larval lamprey populations in a Lake Huron bay tributary. Mich. Dep. Nat. Resour., Res. Dev. Rep. No. 266.

Wainio, A. A. 1962. Rainbow trout in the Nottawasaga River with specific reference to Nicolston Dam. Ont. Fish Wildl. Rev. 1:19-24.

Wainio, A., J. Smitka, I. Veitch, M. Jones, and A. Kaszuba. 1973. A fish survey of the Toronto Islands. Ont. Min. Nat. Resour.

Walburg, C. H. 1972. Some factors associated with fluctuations in year-class strength of sauger, Lewis and Clark Lake, South Dakota. Trans. Am. Fish. Soc. 101(2):311-316.

Walburg, C. H. 1973. Biota of the nearshore waters of Lake Michigan and mortality of organisms caused by water intake structures. Append. C, Pages C-1 to C-38 in Lake Michigan intakes: report on the best available technology, by Lake Michigan Cooling Water Intake Technical Committee.

Walburg, C. H., and W. R. Nelson. 1966. Carp, river carpsucker, smallmouth buffalo, and bigmouth buffalo in Lewis and Clark Lake, Missouri River. U.S. Bur. Sport Fish. Wildl. Res. Rep. 69.

Wallace, D. C. 1972. The ecology of the silverjaw minnow, Ericymba buccata Cope. Am. Midl. Nat. 87(1):172-190.

Wallace, D. C. 1973. Reproduction of the silverjaw minnow, Ericymba buccata Cope. Trans. Am. Fish. Soc. 102(4):786-793.

Wapora, Inc. 1976a. 316(a) demonstration for proposed units 7, 8, and 9 Presque Isle Power Station, Marquette, Michigan.

Wapora, Inc. 1976b. The effects of Presque Isle Power Station on the ecological balance of Presque Isle Harbor. Final rep., April 1975 to July 1976, submitted to Upper Peninsula Generating Co.

Wapora, Inc. 1977a. 316(a) demonstration for Edgewater Generating Station. Submitted to Ohio Edison Co.

Wapora, Inc. 1977b. 316(a) demonstration, Acme Power Station. Submitted to Toledo Edison Co., Proj. No. 163.

Wapora, Inc. 1977c. 316(a) demonstration, Bay Shore Station. Submitted to Toledo Edison Co., Proj. No. 163.

Wapora, Inc. 1978. Ichthyoplankton of the St. Clair River in the vicinity of the St. Clair and proposed Belle River Power Plants, March 28-June 8, 1978, final report. Submitted to Detroit Edison Co., Proj. No. 233.

Wapora, Inc. 1979a. An evaluation of cylindrical wedge-wire screens at cooling water intakes in Lake Michigan, final report. Submitted to Consumers Power Co.

Wapora, Inc. 1979b. Impingement and entrainment at the J. R. Whiting Plant. Submitted to Consumers Power Co.

Wapora, Inc. 1979c. Aquatic survey of Lake Michigan near the Palisades Nuclear plant, Part 4 of 6, Ichthyoplankton, final report. Submitted to Consumers Power Co.

Wapora, Inc. 1979d. Aquatic survey of Lake Michigan near the Palisades Nuclear Plant, Part 5 of 6, juvenile and adult fish, final report. Submitted to Consumers Power Co.

Ward, H. B. 1895. A biological examination of Lake St. Clair. Pages 1-41 in 11th Bienn. Rep. Mich. State Board Fish Comm., 1892-1894.

Ward, H. B. 1896. A biological examination of Lake Michigan. Bull. Mich. Fish Comm. 6:19-20.

Ward, H. B. 1897. The food supply of the fish in the Great Lakes. Pages 117-129 in 12th Bienn. Rep. Mich. State Board Fish Comm., 1894-1896.

Warner, E. N. 1940. Studies on the embryology and early life history of the gizzard shad, Dorosoma cepdianum LeSueur. Ph.D. Thesis, Ohio State Univ.

Warner, J. 1979. Smelt dippers' guide. Mich. Out-of-Doors 33(4):90-92.

Warren, E. 1946. Marsh of many uses--Pte. Mouillee. Mich. Conserv. 15(9):7-9.

Wascko, H., and C. F. Clark. 1951. Pond propagation of bluntnose and blackhead minnows. A contribution of the Ohio Dep. Nat. Resour., Div. Wildl., Wildl. Conserv. Bull. No. 4.

Washburn, G. N. 1944. Experimental cisco netting in Birch Lake, Cass County, Michigan. Mich. Dep. Conserv., Inst. Fish. Res. Rep. No. 948.

Washburn, G. N. 1948. Propagation of the creek chub in ponds with artificial raceways. Trans. Am. Fish. Soc. 75:336-350.

Waybrant, R. C., and J. M. Shauver. 1979. Survey of larval fish in the Michigan waters of Lake Erie, 1975 and 1976. U.S. Environ. Prot. Agency, EPA-600/3-79-095, Environ. Res. Lab., Duluth.

Weber, J. 1971. Winnebago's bonus cod. Wis. Conserv. Bull. 36(6):23.

Weber, J. J. 1975. Golden strands. Wis. Conserv. Bull. 40(2):18-19.

Weber, J., R. Poff, and C. W. Threinen. 1968. Surface water resources of Sheboygan County. Wis. Dep. Nat. Resour., Madison.

Weber, J. J., M. Desparte, and C. W. Threinen. 1968. Surface water resources of Manitowoc County. Wis. Dep. Nat. Resour.

Webster, B. O. 1929. Propagation of muskellunge. Trans. Am. Fish. Soc. 59:202-203.

Webster, D. A. 1941. The life histories of some Connecticut fishes. Pages 122-227, Section III, in A Fishery Survey of Important Connecticut lakes by State Board Fisheries and Game. Conn. State Geol. Nat. Hist. Surv. Bull. No. 63.

Webster, D. A. 1953. Smallmouth bass, Micropterus dolomieui, in Cayuga Lake. Part 1. Life history and environment. State Univ. N.Y., Cornell Exp. Stn. Memoir 327.

Webster, D. A., U. B. Stone, D. G. Paski, and J. L. Forney. 1959. Migration habits of smallmouth bass. N.Y. State Conserv. 13(6):4-8.

Weisel, G. F., and J. B. Dillon. 1954. Observations on the pygmy whitefish, Prosopium coulteri, from Bull Lake, Montana. Copeia 1954(2):124-127.

Wells, L. 1966. Seasonal depth distribution of larval bloaters (Coregonus hoyi) in southeastern Lake Michigan. Trans. Am. Fish. Soc. 95(4):388-396.

Wells, L. 1968. Seasonal depth distribution of fish in southeastern Lake Michigan. U.S. Fish Wildl. Serv. Fish. Bull. 67(1):1-15.

Wells, L. 1972. Letter written to David C. Johnson, Mich. Dep. Nat. Resour. Unpublished data on information regarding bottom types, and use by certain fish, of Lake Michigan waters shallower than 20 fm off Allegan, Van Buren, and Berrien Counties.

Wells, L. 1973. Distribution of fish fry in nearshore waters of southeastern and east-central Lake Michigan, May-August 1972. U.S. Bur. Sport Fish. Wildl., Great Lakes Fish. Lab., Admin. Rep.

Wells, L. 1974. Distribution of fish fry in nearshore waters of southern and central Lake Michigan, May-August 1973. U.S. Bur. Sport Fish. Wildl., Great Lakes Fish. Lab, Admin. Rep.

Wells, L. 1975. Supplementary information on lake trout in Lake Michigan. Append. VI(B), pages 105-110, in Minutes (with append.) of Lake Mich. Comm. 1975 Annu. Meet., Great Lakes Fish. Comm.

Wells, L. 1977a. Changes in yellow perch (Perca flavescens) populations of Lake Michigan, 1954-75. J. Fish. Res. Board Can. 34(10):1821-1829.

Wells, L. 1977b. Status of alewives and yellow perch in Lake Michigan. Append. VII, pages 49-51, in Minutes (with append.) of Lake Mich. Comm. 1977 Annu. Meet., Great Lakes Fish. Comm.

Wells, L. 1980. Foods of alewives, yellow perch, spottail shiners, trout-perch, and slimy and fourhorn sculpins in southeastern Lake Michigan. U.S. Fish Wildl. Serv. Tech. Pap. No. 98.

Wells, L., and R. House. 1974. Life history of the spottail shiner (Notropis hudsonius) in southeastern Lake Michigan, the Kalamazoo River, and western Lake Erie. U.S. Bur. Sport Fish. Wildl. Res. Rep. No. 78.

Wells, L., S. Jorgenson, and R. House. 1971. R/V Cisco, Cruise XII, 1971 (Lake Michigan, November 16-December 4). U.S. Bur. Sport Fish. Wildl., Great Lakes Fish. Lab.

Wells, L., and A. L. McLain. 1972. Lake Michigan: effects of exploitation, introductions, and eutrophication on the salmonid community. J. Fish. Res. Board Can. 29(6):889-898.

Wells, L., and A. L. McLain. 1973. Lake Michigan, man's effects on native fish stocks and other biota. Great Lakes Fish. Comm. Tech. Rep. No. 20.

Werner, R. G. 1967. Intralacustrine movements of bluegill fry in Crane Lake, Indiana. Trans. Am. Fish. Soc. 96(4):416-20.

Werner, R. G. 1969. Ecology of limnetic bluegill (Lepomis macrochirus) fry in Crane Lake, Indiana. Am. Midl. Nat. 81:164-181.

Werner, R. G. 1977. Ichthyoplankton and inshore larval fishes of the St. Lawrence River. Pages 31-60 in Prelim. rep.: Biological characteristics of the St. Lawrence River, J. W. Geis, ed., State Univ. N.Y., Coll. Environ. Sci. For., Inst. Environ. Prog. Affairs.

Werner, R. G. 1979. Homing mechanism of spawning white suckers in Wolf Lake, New York. N.Y. Fish Game J. 26(1):48-58.

Werner, R. G., and D. Ford. 1972. Technical report, fisheries resources. Prep. for the St. Lawrence-Eastern Ont. Comm. by State Univ. N.Y., Coll. Environ. Sci. For.

Westerman, F. A. 1927. Fish Division. Pages 82-129 *in* Mich. Dep. Conserv. 3rd Bienn. Rep., 1925-26.

Westerman, F. A. 1928. Fish Division. Pages 87-121 *in* Mich. Dep. Conserv. 4th Bienn. Rep., 1927-28.

Westerman, F. A. 1930. Fish Division. Pages 191-233 *in* Mich. Dep. Conserv. 5th Bienn. Rep., 1929-30.

Westerman, F. A. 1933. Fish Division. Pages 137-164 *in* Mich. Dep. Conserv. 6th Bienn. Rep., 1931-32.

Westerman, F. A. 1934. Fish Division. Pages 111-154 *in* Mich. Dep. Conserv. 7th Bienn. Rep., 1933-34.

Westerman, F. A. 1937. Fish Division. Pages 117-160 *in* Mich. Dep. Conserv. 8th Bienn. Rep., 1934-36.

Westerman, F. A. 1940. Fish Division. Pages 145-215 *in* Mich. Dep. Conserv. 10th Bienn. Rep., 1939-40.

Westerman, F. A. 1942. Fish Division. Pages 142-227 *in* Mich. Dep. Conserv. 11th Bienn. Rep., 1941-42.

Westerman, F. A. 1946. Fish Division. Pages 231-317 *in* Mich. Dep. Conserv. 13th Bienn. Rep., 1945-46.

Westerman, F. A. 1950. Fish Division. Pages 65-132 *in* Mich. Dep. Conserv. 15th Bienn. Rep., 1949-50.

Westerman, F. A. 1952a. Letter to W. J. K. Harkness, July 1.

Westerman, F. A. 1952b. Fish Division. Pages 68-111 *in* Mich. Dep. Conserv. 16th Bienn. Rep., 1951-52.

Westerman, F. A. 1955. Fish Division. Pages 77-120 *in* Mich. Dep. Conserv. 17th Bienn. Rep., 1953-54.

Westerman, F. A. 1957a. Fish and Fisheries Division. Pages 53-93 *in* Mich. Dep. Conserv. 18th Bienn. Rep., 1955-56.

Westerman, F. A. 1957b. Storm warnings for rainbows. Mich. Conserv. 26(2):12.

Westerman, F. A. 1959. Fish and Fisheries Division. Pages 57-98 *in* Mich. Dep. Conserv. 19th Bienn. Rep., 1957-58.

Westerman, F. A., and J. Van Oosten. 1939. Report to the Michigan State Senate on the fisheries of Potagannissing Bay, Michigan. Mich. Dep. Conserv.

Westman, J. R. 1938. Studies on the reproduction and growth of the blunt-nosed minnow, Hyborhynchus notatus (Rafinesque). Copeia 1938(2):56-61.

Westman, J. R. 1941. A consideration of population life-history studies in their relation to the problems of fish management research, with special reference to the small-mouthed bass, Micropterus dolomieu Lacepede, the lake trout, Cristovomer namaycush (Walbaum), and the mudminnow, Umbra limi (Kirtland). Ph.D. Thesis, Cornell Univ., Ithaca, N.Y.

Westman, R. W. 1974. Sea lamprey survey of the Niagara River, 1973. Append. 8, pages 19-20 in Annu. rep. 1973 Sea Lamprey Control Centre, Sault Ste. Marie, Ont., to the Great Lakes Fish. Comm. of activities carried out under a Memorandum of Agreement during April 1, 1973 to March 31, 1974. Annu. Rep. No. GRL/A-73.

Whillans, T. H. 1977. Fish community transformation in three bays within the lower Great Lakes. M.S. Thesis, Univ. Toronto.

Whillans, T. H. 1979a. Response of fish communities to stress: a historical study of Inner Bay, Long Point. Contact 11(1):1-18.

Whillans, T. H. 1979b. Historic transformations of fish communities in three Great Lakes bays. J. Great Lakes Res. 5(2):195-215.

White, A. M., M. B. Trautman, E. J. Foell, M. P. Kelty, and R. Gaby. 1975. The fishes of the Cleveland metropolitan area including the Lake Erie shoreline. Water quality baseline assessment for the Cleveland area--Lake Erie. Vol. II, U.S. Environ. Prot. Agency, EPA-905/9-75-001, Proj. G005107, sect. 108a program.

White, H. C. 1930. Some observations on the eastern brook trout (S. fontinalis) of Prince Edward Island. Trans. Am. Fish. Soc. 60:101-108.

Whitman, C. O., and A. C. Eycleshymer. 1897. The egg of Amia and its cleavage. J. Morph. 12(2):309-354.

Wickliff, E. L. 1920. Food of young small-mouth black bass in Lake Erie. Trans. Am. Fish. Soc. 50:364-371.

Wickliff, E. L. 1928a. Distribution of fry in the west end of Lake Erie, exclusive of the north shore from May 16-Aug. 28, 1928. Ohio Div. Fish Game, Columbus.

Wickliff, E. L. 1928b. Whitefish egg experiments at the state hatchery, Put-in-Bay, Ohio. Unpubl. rep.

Wickliff, E. L. 1933a. The practical value of determining the fertility of whitefish eggs. Trans. Am. Fish. Soc. 63:144-150.

Wickliff, E. L. 1933b. A review of the status of the mascalonge with special reference to the Ohio or Chatauqua mascalonge. Ohio Dep. Agric., Div. Conserv., Bur. Sci. Res., Bull. No. 27.

Wickliff, E. L. 1936. Fishes of Ohio--natural propagation. Ohio Dep. Agric., Div. Conserv., Bur. Sci. Res., Bull. 123.

Wickliff, E. L. 1938. Smallmouth black bass breeding data for the Bass Islands in Lake Erie during 1919, 1920, 1921, 1922, and 1924. Ohio Div. Fish. Game, Columbus, Unpubl. Mimeo.

Wickliff, E. L. 1957. Breeding habits of several fishes found in Ohio. Ohio Dep. Nat. Resour., Div. Wildl., Bull. No. 66F.

Wickliff, E. L., and G. F. Miller. 1929. Artificial propagation of fish in Ohio. Ohio Div. Conserv. Bull. No. 28.

Wicklund, R. G., and C. D. Bryron. 1957. Little Manistee River watershed. Mich. Dep. Conserv. Surv. Plans Rep.

Wigley, R. L. 1953. The life history of the sea lamprey, Petromyzon marinus Linnaeus, of Cayuga Lake, New York. Ph.D. Thesis, Cornell Univ.

Wigley, R. L. 1959. Life history of the sea lamprey of Cayuga Lake, New York. U.S. Fish Wildl. Serv. Fish. Bull. 59:561-617.

Williams, J. E. 1951. The lake sturgeon. Mich. Conserv. 20(6):15-18.

Williams, J. E. 1954a. Spawn collection and spawning habits of the northern muskellunge in Gogebic County during 1954. Mich. Dep. Nat. Resour. Inst. Fish Res. Rep. No. 1430.

Williams, J. E. 1954b. Creel census and life history observations concerning muskellunge in Michigan inland waters. Mich. Dep. Nat. Resour. Inst. Fish. Res. Rep. No. 1432.

Williams, J. E. 1959. The muskellunge in Michigan. Mich. Dep. Conserv. Fish Div. Pamphlet No. 30.

Williams, J. E. 1961. The muskellunge in Lake St. Clair. Mich. Dep. Conserv. Inst. Fish. Res. Rep. No. 1625.

Williams, J. E., and B. L. Jacob. 1971. Management of spawning marshes for northern pike. Mich. Dep. Nat. Resour. Res. Dev. Rep. No. 242.

Williamson, L. O. 1939. The fat-head minnow as a forage fish. Wis. Conserv. Bull. 4(6):50-51.

Williamson, L. O. 1942. Spawning habits of muskellunge and northern pike. Wis. Conserv. Bull. 7(5):10-11.

Williamson, L. O., and W. S. Churchill. 1948. Largemouth bass population in Punch Lake, T4IN, R6E, S35, Vilas County. Wis. Conserv. Dep. Sec. Fish. Biol., Invest. Rep. No. 515.

Williamson, R. F. 1951. A pre-historic killer--the longnose gar. Pa. Angler 20(6):4-6.

Willis, T. B. 1975. Monthly and daily abundance of fish captured by near-shore trawling and seining at sites in Indiana waters of Lake Michigan, near Michigan City, Indiana in 1973. M.S. Thesis, Ball State Univ.

Winchester, G. E. 1912. The hatcheries--Chautauqua station. *In* The annu. rep. Fish Cult., T. H. Bean, ed. Extract Annu. Rep. Conserv. Comm., 1911.

Winchester, G. E. 1915. The hatcheries--Chautauqua station. Page 344 *in* N.Y. Fourth Annu. Rep. Conserv. Comm.

Winn, H. E. 1953. Breeding habits of the percid fish *Hadropterus copelandi* in Michigan. Copeia 1953(1):26-30.

Winn, H. E. 1954. Comparative reproductive behavior and ecology of fourteen species of darters (Pisces-Percidae). Ph.D. Thesis, Univ. Mich.

Winn, H. E. 1957. Egg site selection by three species of darters (Pisces-Percidae). J. Anim. Behav. 5(1):25-28.

Winn, H. E. 1958a. Comparative reproductive behavior and ecology of fourteen species of darters. Ecol. Monogr. 28(2):155-191.

Winn, H. E. 1958b. Observations on the reproductive habits of darters (Pisces-Percidae). Am. Midl. Nat. 59:190-212.

Winn, H. E. 1960. Biology of the brook stickleback *Eucalia inconstans* (Kirtland). Am. Midl. Nat. 63(2):424-438.

Winterton, G. K. 1970. Proposed improvements to the pickerel spawning area, Shawanaga River. Ont. Min. Nat. Resour.

Winterton, G. K. 1972. Georgian Bay yellow pickerel project progress report--1971. Ont. Min. Nat. Resour.

Winterton, G. K. 1975. Structure and movement of a spawning stock of walleye *Stizostedion vitreum vitreum* (Mitchill) in Georgian Bay. M.S. Thesis, Univ. Guelph.

Wirth, T. L. 1958. Lake Winnebago freshwater drum. Wis. Conserv. Bull. 23(5):30-32.

Wisconsin Department of Agriculture and Markets. 1936. Biennial report, Department of Agriculture and Markets. Wis. Dep. Agric. Markets Bull. 178.

Wisconsin Department of Natural Resources. 1972. Progress report on Lake Michigan--1971. Wis. Dep. Nat. Resour., Div. For., Wildl., Rec., Bur. Fish. Manage.

Wisconsin Department of Natural Resources. 1974a. Northern pike tag book. Mink River.

Wisconsin Department of Natural Resources. 1974b. Progress report of fish management on Lake Michigan, 1973.

Wisconsin Department of Natural Resources. 1975. Lake trout reef seeding. Append. VII, pages 109-110, in Minutes (with append.) of Lake Mich. Comm. 1975 Annu. Meet., Great Lakes Fish. Comm.

Wisconsin Department of Natural Resources. 1976. Notes on west shore northern pike spawning areas, unpubl. data.

Wisconsin Department of Natural Resources. 1977. Walleye stocking evaluation--Green Bay, 1977.

Wisconsin Department of Natural Resources. 1979a. Annual stocking report--walleye assessment. Proj. AFC-14, July 1, 1978-June 30, 1979.

Wisconsin Department of Natural Resources. 1979b. Unpublished data of stocking (from Green Bay office).

Wisconsin Electric Power Co. undated. Non-radiological environmental surveillance program, Point Beach Nuclear Plant Unit Nos. 1 and 2, five year summary report, November 1972 through October 1977.

Wisconsin Electric Power Co. 1975a. Demonstration that no prior appreciable harm (to the aquatic biota of Lake Michigan) has resulted from the thermal component of the Point Beach Power Plant discharges.

Wisconsin Electric Power Co. 1975b. Demonstration that no appreciable harm (to the aquatic biota of Lake Michigan) has resulted from the thermal component of the Oak Creek Power Plant discharges.

Wisconsin Electric Power Co. 1975c. Demonstration that no prior appreciable harm (to the aquatic biota of Lake Michigan) has resulted from the thermal component of the Lakeside Power Plant discharge.

Wisconsin Electric Power Co. 1976a. Lakeside Power Plant final report on intake monitoring studies performed by Wisconsin Electric Power Company in fulfillment of conditions of Wisconsin Pollution Discharge Elimination System, Permit Number WI-0000906.

Wisconsin Electric Power Co. 1976b. Commerce Street Power Plant, final report on intake monitoring studies.

Wisconsin Electric Power Co. 1976c. Point Beach Nuclear Plant, final report on intake monitoring studies performed by Wisconsin Electric Power Company in fulfillment of conditions of Wisconsin Pollution Discharge Elmination System, Permit No. WI-0000957.

Wisconsin Electric Power Co. 1976d. Oak Creek Power Plant. Final report on intake monitoring studies performed by Wisconsin Electric Power Co. in fulfillment of conditions of Wisconsin Pollution Discharge Elimination System.

Wisconsin Electric Power Co. 1976e. Port Washington Power Plant, final report on intake monitoring studies.

Wisconsin Electric Power Co. unpubl. data. (Ford River, Haven, and Port Washington), 1978-79.

Wisconsin Electric Power Co., and Wisconsin Michigan Power Co. 1970. Applicants environmental report, operating license stage, Point Beach Nuclear Plant Unit No. 2. U.S. Atomic Energy Comm. Docket No. 50-301.

Wisconsin Electric Power Co., and Wisconsin Michigan Power Co. 1971a. Supplement to applicant's environmental report, operating license stage, Point Beach Nuclear Plant Unit No. 1. U.S. Atomic Energy Comm. Docket No. 50-266.

Wisconsin Electric Power Co., and Wisconsin Michigan Power Co. 1971b. Supplement to applicants' environmental report, operating license stage, Point Beach Nuclear Plant Unit No. 2. U.S. Atomic Energy Comm. Docket No. 50-301.

Wisconsin Electric Power Co., and Wisconsin Michigan Power Co. undated (a). Point Beach Nuclear Plant, Unit Nos. 1 and 2, non-radiological environmental surveillance program, annual report number 1, 1 September 1972 through 1 November 1973. Vol. 3. U.S. Atomic Energy Comm. Docket Nos. 50-266 and 50-301.

Wisconsin Electric Power Co., and Wisconsin Michigan Power Co. undated (b). Point Beach Nuclear Plant, Unit Nos. 1 and 2, non-radiological environmental surveillance program, annual report number 1, 1 September 1972 through 1 November 1973. Vol. 4. U.S. Atomic Energy Comm. Docket Nos. 50-266 and 50-301.

Wisconsin Electric Power Co., and Wisconsin Michigan Power Co. undated (c). An environmental study of the ecological effects of the thermal discharge from the Point Beach Nuclear Plant, Nov. 1975 through Oct. 1976. In Wis. Electr. Power Co. and Wis. Mich. Power Co. Non-radiol. environ. surv. program. Pt. Beach Nucl. Plant, Unit Nos. 1 and 2. Annu. Rep. No. 4, Nov. 1975-Oct. 1976, U.S. Nucl. Regul. Comm. Docket Nos. 50-266 and 50-301.

Wisconsin Electric Power Co., Wisconsin Power and Light, and Wisconsin Public Service Corp. 1979a. 316(a) demonstration, Haven Nuclear Plant, Wisconsin Utilities Project.

Wisconsin Electric Power Co., Wisconsin Power and Light, and Public Service Corp. 1979b. 316(b) demonstration, Haven Nuclear Plant, Wisconsin Utilities Project.

Wisconsin Public Service Corporation. 1971. Environmental report--operating license stage. Kewaunee Nuclear Power Plant.

Wohlgemuth, O. 1978. Investigation of whitefish spawning areas, Marks and Leighs Bays, St. Marys River, Sault Ste. Marie District, 1978. Ont. Min. Nat. Resour., unpubl. rep.

Wolfe, C. A. 1958. Smelt. Fish Wildl. Annu. Rep., Ont. Dep. Lands For., Lake Erie Dist., Vol. 1:8.

Wolfe, C. A. 1959. Smelt survey--1958. Fish Wildl. Annu. Rep., Ont. Dep. Lands For., Lake Erie Dist., Vol. 2:36-37.

Wolfert, D. R. 1963. Movements of walleyes tagged as yearlings in Lake Erie. Trans. Am. Fish. Soc. 92(4):414-420.

Wolfert, D. R. 1964. Food of young of the year walleyes in Lake Erie. U.S. Fish. Wildl. Serv. Fish. Bull. 65(2):489-494.

Wolfert, D. R. 1969. Maturity and fecundity of walleyes from the eastern and western basins of Lake Erie. J. Fish. Res. Board Can. 26:1877-1888.

Wolfert, D. R. 1977. Age and growth of the walleye in Lake Erie, 1963-68. Trans. Am. Fish. Soc. 106(6):569-577.

Wolfert, D. R., W-D. N. Busch, and C. T. Baker. 1975. Predation by fish on walleye eggs on a spawning reef in western Lake Erie. Ohio J. Sci. 75(3):118-125.

Wolfert, D. R., W-D. N. Busch, and H. D. Van Meter. 1978. Seasonal abundance of fish in an inshore area of southcentral Lake Erie, 1974-75. U.S. Fish Wildl. Serv. Great Lakes Fish. Lab., Admin. Rep.

Wolfert, D. R., and H. D. Van Meter. 1978. Movements of walleyes tagged in eastern Lake Erie. N.Y. Fish Game J. 25(1):16-22.

Woner, P. 1963. Lake Erie fish population gill netting and shore seining survey. Ohio Dep. Nat. Resour., Job Prog. Rep., Dingell-Johnson Proj. No. F-35-R-1, Job No. 4, Nov. 1960-Oct. 1962.

Wooton, R. J. 1976. The biology of the sticklebacks. Academic Press, N.Y.

Wright, A., T. Stauffer, R. Schorfhaar, and J. Peck. 1975. Progress reports in selected research and management projects in Lake Superior, 1974. Append. VI in Minutes of the Lake Superior Comm. Annu. Meet.:59-68. Mich. Dep. Nat. Resour. Fish. Div.

Wright, E. P. 1879. On the development of the garpike (Lepisosteus osseus). Nature 19:100-101.

Wright, S. 1955. Limnological survey of western Lake Erie. U.S. Fish Wildl. Serv. Spec. Sci. Rep.-Fish. No. 139.

Wright, S., and W. M. Tidd. 1933. Summary of limnological investigation in western Lake Erie in 1929 and 1930. Trans. Am. Fish. Soc. 63:271-285.

Yager, R. O., and T. McComish. 1976. Spottail shiner food habits with notes on competition for food in Indiana waters of Lake Michigan. Fish and Wildlife in Indiana, 1776-1976, and reports of fish and wildlife studies. Pages 66-69 in Proc. of the joint meeting of the Am. Fish. Soc. and the Wildl. Soc., Bradford Woods, 1976.

Zafonte, C. W. 1977. U.S. Environ. Prot. Agency letter to Buffalo District, U.S. Corps of Engineers. Pages E-20 in Final environmental impact statement, permit application by Niagara Mohawk Power Corp. proposed Lake Erie Generating Station, undated.

Zeitoun, I. H., J. A. Gulvas, and N. C. Van Wagner. 1978. The assessment of fish impingement at J. H. Campbell Plant Units 1 and 2: June 13 to December 22, 1977. Consumers Power Co., Dep. Environ. Serv., Tech. Rep. No. 14.

Zimmerman, C. J. 1970. Growth and food of the brook silverside, Labidesthes sicculus, in Indiana. Trans. Am. Fish. Soc. 99(2):435-438.

Zimmerman, F. A. 1968. Michael Bay sea lamprey control and rainbow trout tagging programme 1968. Ont. Min. Nat. Resour.

Zimmerman, J. F. 1966. Georgian Bay walleye project progress report 1966. Ont. Min. Nat. Resour., Maple.

Zimmerman, J. F. 1967. Georgian Bay walleye project progress report 1967 and six year summary report of walleye trapping and tagging on Georgian Bay 1962-1967. Ont. Dep. Lands For., unpubl.

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16. Abstract (Limit: 200 words)

This atlas is a compilation of current spawning and nursery information concerning the fishes of the Great Lakes. The complete set consists of fourteen volumes. The information may be used to support permit and project reviews, impact statement reviews, planning of baseline research, and corrdination with other agencies, and identification of data gaps. The report locates spawning and nursery areas in the Great Lakes and describes spawning and nursery characteristics, timing, and habitats of major fish species of the Great Lakes area. The first volume is a summary by geographic area, volumes II through XII contain the specific areas referenced in volume I. Volume XIII contains the species spawning and nursery characteristics for the major species, and Volume XIV cites the references used in compiling this work.
The titles of the volumes addressing the spawning and nursery areas for each fish species site specifically are: II, Lake Superior; III, St. Mary's River; IV, Lake Michigan; V, Lake Huron; VI, St. Clair River; VII, St. Clair Lake; VIII, Detroit River; IX, Lake Erie; X, Niagara River; XI, Lake Ontario; XII, St. Lawrence River. The title of Volume XIV is, Species Reproduction Characteristics.

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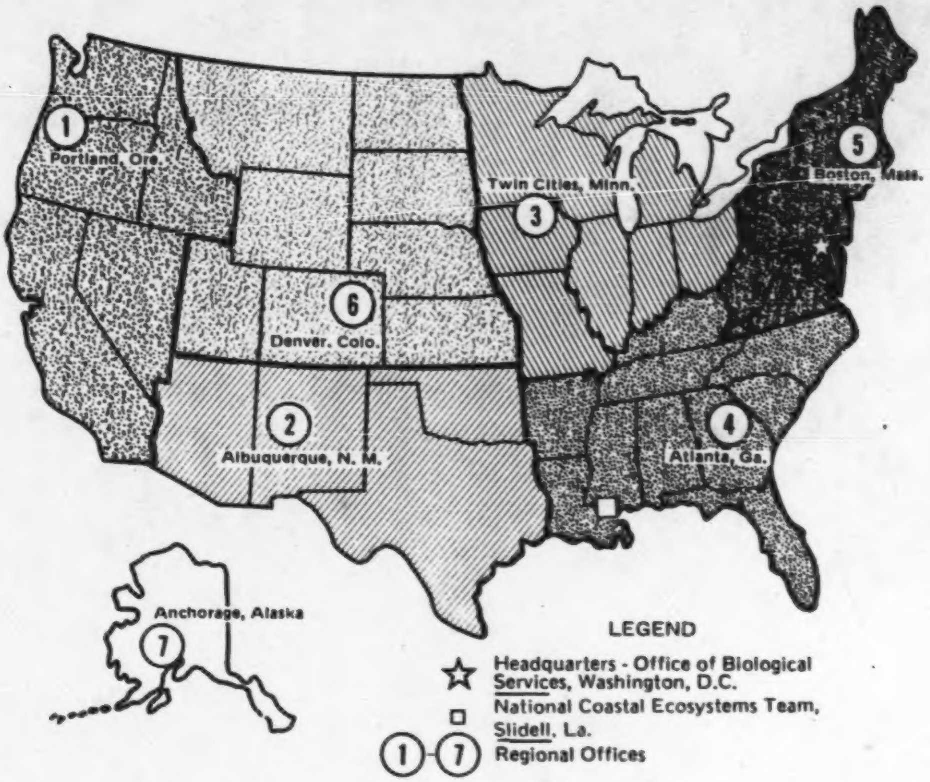
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